SCIENCE

VOL. 91 FRIDAY, FEBRUARY 9, 1940 No. 2354

The First Forty Years of the Society of American Bacteriologists: DR. C.-E. A. WINSLOW 125
Presentation of the Gold Medal of the American Institute of the City of New York:
A Modern Pioneer: DR. DAVID SARNOFF 129
The Story of Short Waves: DR. FRANK CONRAD 131
Obituary:
Frederic Schiller Lee: DR. HORATIO B. WILLIAMS. *Alfred George Jacques:* DR. W. J. V. OSTERHOUT. *Recent Deaths and Memorials* 133
Scientific Events:
Annual Report of the Director of the New York Botanical Garden; Enlargement of the Chemistry Building of the University of Cincinnati; Officers of the Washington Academy of Science; The Summer Meetings of Botanists; The American Chemical Society and Dr. Springer 135
Scientific Notes and News 137
Discussion:
An Endemic Palm on Cocos Island near Panama Mistaken for the Coconut Palm: DR. O. F. COOK. *Momentum and Energy:* PROFESSOR R. F. DEIMEL. *The Usefulness of Biological Abstracts:* DR. CARL G. HARTMAN 140
Scientific Books:
Terrestrial Magnetism and Electricity: DR. W. F. G. SWANN. *Modern Science:* DR. C. G. MONTGOMERY. *Prehistoric Life:* PROFESSOR HERVEY W. SHIMER 142
Societies and Meetings:
The Tennessee Academy of Science: PROFESSOR J. T. MCGILL 144
Special Articles:
Resonance and the Chemistry of Histidine: TERRELL L. HILL and PROFESSOR GERALD E. K. BRANCH. *Further Evidence of Sex Variation in the Utilization of Iron by Anemic Rats:* DR. LOUISE OTIS and DR. MARGARET CAMMACK SMITH. *On the Origin of Urogastrone:* C. U. CULMER and OTHERS 145
Scientific Apparatus and Laboratory Methods:
A Roller Bottle Tissue Culture System: DR. DARRELL T. SHAW, LAWRENCE C. KINGSLAND and DR. AUSTIN M. BRUES. *The Use of a Translongitome in Making and Interpreting Alternate Transverse and Longitudinal Serial Sections:* PROFESSOR D. M. CROOKS 148
Science News 5

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. MCKEEN CATTELL and published every Friday by

THE SCIENCE PRESS
New York City: Grand Central Terminal
Lancaster, Pa. Garrison, N. Y.

Annual Subscription, $6.00 Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary in the Smithsonian Institution Building, Washington, D. C.

THE FIRST FORTY YEARS OF THE SOCIETY OF AMERICAN BACTERIOLOGISTS[1]

By Dr. C.-E. A. WINSLOW

PROFESSOR OF PUBLIC HEALTH, YALE SCHOOL OF MEDICINE

THE last ten years of the nineteenth century are perhaps best known by the term "the gay nineties." A more important taxonomic characteristic is perhaps expressed in the description of this decade, and the one preceding it, as "the golden age of bacteriology." Between 1880 and 1900, a new science was born, a science fraught with rich gifts of health and happiness for the human race and one which—unlike many other sciences—has been used by man only for beneficent purposes. It was natural, therefore, that toward the close of this century the devotees of this new science should organize for the better performance of their challenging task.

This tendency took shape in the establishment of the Laboratory Section of the American Public Health Association at the Minneapolis meeting in 1899. Our own society was, however, the first independent organization devoted specifically to the service of bacteriology in the United States—perhaps in the world.

The idea was first evolved by A. C. Abbott, H. W. Conn and E. O. Jordan at the 1898 meeting of the American Society of Naturalists, and the new organization was conceived as an affiliate of that society. On October 17, 1899, a circular letter was sent out by the three pioneers to some forty bacteriologists, and on December 28, 1899, the organization meeting of the Society of American Bacteriologists was held at the Yale Medical School, in response to this call. W. T.

[1] Address delivered at the Fortieth Anniversary Meeting of the Society of American Bacteriologists, New Haven, Conn., December 29, 1939.

Sedgwick was chosen as the first president of the new organization, A. C. Abbott as vice-president and H. W. Conn as secretary-treasurer.

It is of interest to note that December 29 is Professor Sedgwick's birthday. If he were with us on this occasion to accept our tributes of affection, he would be eighty-four years old.

Of the 57 charter members of the society then formed, 18 are known to be still living and 7 of the 18 are present at this fortieth anniversary. The survival powers of the staunch 18 will be duly recognized before the close of this meeting; but a word of tribute is in order to the members of our fellowship who have passed on the torch of progress to our hands. Rarely, I think, has a new organization enjoyed the leadership of so distinguished a band of sponsors. In this group were A. C. Abbott, bon-vivant and leader of medicine in Philadelphia; J. Adami, distinguished Canadian pathologist; H. W. Conn, typical New Englander, decorous, keen-witted and sure; E. K. Dunham, of New York City's élite, wise counselor to many; F. P. Gorham, genial founder of a vigorous department at Brown and faithful public servant of Rhode Island; George W. Fuller, dominant figure in the development of sanitary engineering, a mind of razor keenness in some 250 pounds of flesh; Wyatt Johnston, pioneer water bacteriologist, of Montreal; E. O. Jordan, frail and gentle, but full of rich accomplishment as teacher, as investigator and as author of a great text-book, tireless in service and wise in counsel; L. P. Kinnicutt, gracious and aristocratic teacher of sanitary chemistry at Worcester; Veranus Moore, of Cornell, pioneer veterinary bacteriologist and able administrator; William H. Park, genial and kindly, founder and for forty years head of New York City's Health Department Laboratory, co-author (with Robert Koch) of the theory of the well carrier, whose brilliant contributions to science, in connection with the bacteriology and immunology of diphtheria, place him among the world's great bacteriologists; T. M. Prudden, thoughtful, ascetic and precise, a power behind the throne in the reorganization by Hermann Biggs of the New York City and State Health Departments; W. T. Sedgwick, beloved teacher and unselfish public servant, founder at the Massachusetts Institute of Technology of our first widely influential school of public health; Erwin F. Smith, father of plant pathology in the United States; Theobald Smith, incomparable scientist, sparse and dry and black-bearded, so imaginative that he anticipated in the nineties many of the "discoveries" made by others for a quarter of a century, so uncannily clear-headed a thinker and so meticulous an investigator that he left no errors for his successors to correct; G. M. Sternberg, of the Army Medical Corps, author of one of our first text-books of bacteriology; Victor C. Vaughan, rugged and salty, a fiery driving force in American medicine; William H. Welch, pioneer pathologist, statesman of medical education and of public health, expert in medical history, as genial a bon-vivant as Abbott, as wise a counselor as Jordan, tireless in energy as Fuller, kindly and helpful as Sedgwick. We knew them all. We loved and admired them all. We honor their memory and pledge our best efforts to carry on the tradition they have left for us.

During these forty years, the society which these men established has grown beyond their fondest dreams. Founded in 1899, we passed through a lag period of about five years, membership increasing only to about 100 by 1905. A phase of late lag or slowly accelerating growth brought us to 300 members in 1915. Between 1915 and 1923 occurred the phase of logarithmic increase, bringing the membership up to over 1,200 in the latter year. The generation time in this phase was therefore about four years. During the depression, the nutritive value of our national culture medium was so reduced that the membership curve dropped to less than 800 in 1932. The amino-acids introduced by the New Deal stimulated a second rise, however, and to-day we are nearly 1,400 strong. No toxic waste products of dissension have been manifest; and the services of Hitchens and Sherman and Baldwin as our beloved secretaries have at all times provided valuable regulative factors.

Meanwhile, gonidial budding has added to the vitality of the parent stock. Beginning with Washington in 1917, local branches have been established (under the leadership of Conn and Koser) to the number of 17, extending from the Connecticut Valley to Southern California.

Our annual meetings have been notably successful, particularly since the establishment in 1925 of the program committee, which through its successive chairmen, Bayne-Jones, Cohen, Frazier and Berry, has functioned to perfection. Our sponsorship of the International Microbiological Congress of 1939, under the presidency of Rivers, is another feather in the cap of the society.

We have operated the *Journal of Bacteriology* since 1916, the *Abstracts of Bacteriology* from 1917 to 1925, *Bacteriological Reviews* since 1937 and *Microbiological Abstracts* since 1938. Our share in the management of the American Type Culture Collection since 1925, the development of the Descriptive Chart by Chester in 1905 and by H. J. Conn since 1917, and the admirable work of the Archives Committee under Cohen since 1934 have made notable contributions to research and teaching and to the cultural and historical backgrounds of our science.

Such a society as ours is not an end in itself but a means for the promotion of the field of knowledge which it represents. What has happened to the science of bacteriology in these four decades which we review to-night?

It will be of interest to turn back to the program of the first New Haven meeting to see what the bacteriologists of 1899 were really doing and thus give us a datum line for measuring the progress made since then. There were 25 papers on this first program which may be subdivided roughly as follows.

There were four papers on this program dealing primarily with descriptions or demonstrations of specific organisms; on *Bacillus enteritidis* by Gehrmann, on the plague bacillus by Park, on a new sporothrix by Hektoen and on Actinomyces by Ernst. The earlier phase of discovery of new organisms had already passed its zenith.

Two papers by Conn and Theobald Smith dealt with variation in bacteria, and two, by Chester and Erwin F. Smith, with taxonomic problems, an early indication of the society's later interest in such problems.

Four papers only dealt with researches bearing on the physiological reactions of bacteria, and these on a very elementary plane. Harding presented two of these, on steam sterilization, Sedgwick and the speaker discussed the influence of cold on the typhoid bacillus, and Erwin Smith the antiseptic properties of thymol and chloroform.

One paper by Ernst dealt with the teaching of bacteriology and one only touched on serology, a study by Park on the effect of blood serum from tubercular animals and men upon the tubercle bacillus.

The rest of the papers presented were in three different fields of applied bacteriology. Five of them dealing with water and sewage bacteriology were contributed by Clark and Gage, Jordan, Moore and Wright, and Kinnicutt; four, on milk bacteriology by Conn, Leighton, Keith and Ward; two on industrial bacteriology by Leow (tobacco fermentation) and Prescott and Underwood (canned foods).

The bacteriologist of 1899 was not, however, so helpless as one might imagine. To check my memory of what I thought I was taught as a student at this time, I have referred to the fifth edition of A. C. Abbott's "Principles of Bacteriology," published in the year that this society was founded. Here we find the general nature and morphology of bacteria and of their chemical activity well described, but with no attempt at classification and no consideration of variation. The influence of oxygen and temperature upon their growth was recognized and the action of disinfectants (including even the factor of ionic dissociation) intelligently discussed. Methods of sterilization were well developed, incubators available and plating on solid media (including the new Petri dish, as well as the ice-cooled mechanically leveled plane glass plate) described. Broth and serum media and the Smith fermentation tube were in use for colonial and biochemical studies, with staining fluids (fuchsin, gentian-violet and methylene blue) as well as the gram stain, flagella stain and stain for the tubercle bacillus. Animal inoculation procedures were of course described. In the chapters dealing with specific organisms, we find the major characteristics of the common staphylococci and streptococci, of the gonococcus, the Pfeiffer bacillus, the causative agents of plague, tuberculosis, typhoid, cholera, diphtheria, anthrax and tetanus, the colon bacillus, the nitrifiers, the spirilla and vibrios. A chapter on "Infection and Immunity" emphasizes the evidence for active humoral immunity in such diseases as diphtheria and tetanus and describes the phenomena of phagocytosis. Concluding chapters deal with very primitive procedures for the study of the bacteriology of water and air and for the testing of disinfectants. We learned a good deal as students in the laboratories of the nineties.

The knowledge then available even to such a genius as Theobald Smith was, however, but a tiny fraction of what the graduate from an elementary course in bacteriology has at his disposal to-day. To refresh my memory, I have read through the 277 pages of Dr. Bayne-Jones' invaluable index to the first 30 volumes of our journal published between 1916 and 1935. I hasten to admit that an occasional valuable contribution may have seen the light in some other publication; but I believe that the *Journal of Bacteriology* presents an excellent mirror of the progress of our science. Let us use its columns as at least a fair random sample of what bacteriology has come to mean to-day and note how its scope has broadened and its penetration deepened since the days of the founders.

First of all, we may note some of the most important of the species and groups of bacteria which were unknown or almost unknown in 1898 and yet have come to be subjects of major interest to-day. Here we may list the dysentery group and the Salmonellas, *Treponema pallidum*, the undulant fever and tularemia organisms, the diverse serological and cultural types of pneumococci, meningococci and streptococci, the fusiforms and new anaerobic spore-formers, the azotobacter group and the rhizobia, the actinomycetes, the propionic bacteria, the cellulose-destroyers, the thermophiles and the sulfur bacteria. All these and many more are discussed in detail in the pages of the journal; and even more startling to the fathers of bacteriology would have been the papers (beginning in 1927) on the viruses of plant diseases, of herpes, of vaccinia, of poliomyelitis and encephalitis, of influenza and the common cold.

Our society has not, however, been content to study these varied types of new organisms which the science of bacteriology has revealed as isolated and accidental phenomena. In our very first volume, we find papers on the classification of the aerobic spore-formers and of the colon-typhoid group and on the grouping of strains of meningococci. In the next year, 1917, Buchanan began his epoch-making contributions to systematic bacteriology, and the Committee on Characterization and Classification of Bacterial Types made its first report. In the next year, 1918, Conn's Committee on Methods of Pure Culture Study began its fruitful labors. It may fairly be claimed that the United States has led the world in the field of bacterial taxonomy.

The notable achievements of the taxonomists are secure; but their significance is modified, though not in any sense discredited, by the somewhat malicious efforts of the students of variation. The tremendously important phenomenon of dissociation does not appear in the index of our journal till 1920 and becomes important there only with the work of Hadley and Soule in 1927. In the very first volume, however, there appears a pioneer contribution on "life cycles" from Löhnis and Smith, and in 1917 Mellon enters the picture with an even bolder challenge. To-day, our conception of a bacterial type must include not one but all of the characteristics which it and its dissociants may assume under varying environmental conditions.

Allied to this problem of variation, but quite distinct from it, are the phenomena of the culture cycle, reproducing in each individual medium-habitat a series of changes analogous to those which occur in the body of a multicellular organism. From the work of Clark and Ruehl in 1919, that of Sherman and Albus in 1923, Bayne-Jones in 1929 and a group of Yale workers in the thirties, this field of research has been developed in our journal, though Henrici unfortunately sought other channels of publication and, in the present discussion, must be sternly ignored.

Even more fundamental are the complex researches which have been made in the field of bacterial metabolism. The exhaustive study of nutritive requirements, the amino-acids, the salts, the vitamins and other accessory substances and the ingenious analysis of the organic materials which are synthesized or formed by decomposition which we owe to such laboratories as those of Rettger and Fred are exhaustive and profound.

Along with metabolism, the second major problem of bacterial physiology is that of the chemical and physical conditions limiting growth and viability. The columns of the journal contain numerous valuable practical contributions on limiting values for heat treatment and chemical disinfection. The most important contribution in this area, and one of the most significant of all American contributions to bacteriology, is the classic paper of Clark and Lubs on the colorimetric determination of hydrogen-ion concentration, published in 1917. If you will try to imagine bacteriological and serological technique without modern methods of measuring pH you will realize the magnitude of this achievement.

In 1928 Cohen and Thornton and Hastings presented to the readers of the journal another highly significant conception—that of oxidation-reduction potentials. In 1921, Holm and Sherman and, in 1923, Falk and the speaker opened up the quantitative study of the stimulating and inhibiting effects of cations. In 1926 Rettger and Valley demonstrated the essential need for carbon dioxide in stimulating bacterial growth. The influence of surface tension, the effect of radiation, the destructive power of bacteriophagy, have been the subject of other significant series of contributions.

The bacteria have been followed from the laboratory out into their natural habitats, up in the clouds by Proctor, down into the depths of the sea by ZoBell. Henrici has revealed to us a whole new world of lake bacteria, sessile forms which the traditional techniques of bacteriology passed by unseen.

Of equal practical and theoretical importance is the vast field of serology, now almost as extensive as bacteriology itself, but existent only as a bare initial outline when this society was founded. Toxins and antitoxins, complements and antigens, precipitation, neutralization and skin reactions, hemolysins and carbohydrate fractions fill many of the pages of our journal, and their utilization saves tens of thousands of lives each year in the United States.

Finally, less dramatic but in the long run equally significant for human welfare, are the numerous contributions by our members in the practical fields of water analysis, of stream pollution and sewage disposal; of dairy bacteriology (with titles occupying five pages in the index to our journal, and beginning with Frost's description of his microscopic counting method in 1916); of soil bacteriology and of industrial bacteriology.

I think you will agree that the first forty years of American bacteriology has justified the wisdom of the founders. What are the prospects for the four decades to come?

Here inspiration fails me. I am neither a prophet nor the son of a prophet. But I do know this. The future of our science depends on the young men just beginning or completing their graduate work, the young men who sit in this audience as I sat at the meetings of 1899. It is to their hands that we commit the torch, and it is their vigilance that must keep the flame burning.

Science does not always go forward. Sometimes it halts and stumbles. During the past few months I have been studying a period when this occurred—a period when prolonged gestation delayed the birth of the science of bacteriology, and, in particular, of the germ theory of disease, for a century and a half.

The plague tracts of the fourteenth century recognized the importance of contagion in the spread of epidemic disease as clearly as we recognize it to-day; and in the sixteenth century, Fracastorius developed a complete and closely reasoned theory of contagion by direct contact, through the air and by fomites which can scarcely be improved upon in 1939. The contagious element was, however, conceived in chemical rather than biological terms. Although Fracastorius wrote of "germs" or "seminaria," it is clear from the context that the term was used only as we might speak of "the germ of an idea" and not as implying living organisms.

This gap in epidemiological thinking was, however, filled in the seventeenth century. Athanasius Kircher, in his "Scrutinium Pestis" in 1658, first clearly advanced in definite and challenging terms the theory that communicable disease was due to *"contagia animata"* to minute living "worms"; and he backed up his contention by actual observation of such worms in decomposing organic matter and, perhaps, in the tissues of plague patients themselves. With the microscopes at his disposal he did not, of course, see bacteria; but his championship of the conception of living germs as the cause of disease is a landmark in the history of epidemiology.

Kircher held that the germs he postulated were spontaneously generated in decomposing organic matter. Ten years later, in 1668, Francesco Redi, in his "Experiments on the Generation of Insects," corrected this error and demonstrated experimentally that—for the maggots of insects at least—spontaneous generation did not occur, but that, when living matter was apparently produced from dead matter, the seeds of life must be introduced from outside.

Within one more decade, in 1676, Antony van Leeuwenhoek of Delft actually discovered the bacteria with his powerful magnifying glasses and described them in his epoch-making letter to the Royal Society of London—the letter which Cohen has reproduced and published for our society in full. Thus, by 1700, there was available the *"contagium animatum"* concept of Kircher, the demonstration of biogenesis by Redi and the discovery of the bacteria by Leeuwenhoek. If an open-minded and imaginative observer had put the work of these three pioneers together, the germ theory of disease could have been developed in the seventeenth century instead of the nineteenth.

Unfortunately, there was no leader in seventeenth century medicine capable of accomplishing such a synthesis. On the contrary, Thomas Sydenham, its outstanding figure, ignored the factor of contagion almost completely and based his whole theory of epidemiology on the epidemic constitution of the atmosphere, an occult property beyond the power of observation, let alone measurement; hence, nearly two centuries of sterile philosophizing and controversy between miasmatists and contagionists—which was only terminated by the experimental methods of Louis Pasteur.

The bacteriologist of 1940 will not need warning against the errors of Sydenham's approach. We have learned the lesson that the assumption of a force beyond the scope of actual observation leads to metaphysics and not to science. There is another lesson from this seventeenth century situation which has, I believe, a fundamental message for us. That lesson is the importance of openmindedness and imagination in visualizing the importance of new observational and experimental data in fields allied to—but somewhat removed from—our own. There is a similar lesson in more recent experience. It is astounding to me to realize that I, with all the bacteriologists of my generation, had under my nose each day plates containing rough and smooth colonies, and for twenty years we ignored them. Even the scientist too often sees with his mind and not with his eyes. Custom and inertia blind him to the light that is ready to pour in. If you young men are to carry on the torch of bacteriology, keep your minds free from hampering pre-conceptions and open to new truth. I once had in my laboratory a text on the wall which read, "The experiment which succeeds teaches us nothing." If things come out as we have anticipated, we are only craftsmen perfecting an edifice already erected by others. The exception to the rule, the unexpected result, the novel observation in some other science which can be related to our own—these are the materials by which the new cathedrals of science are built. If you who are beginning your careers have courage and imagination, curbed always with the bit of experimental verification, the second forty years of American bacteriology will be more glorious than the first.

PRESENTATION OF THE GOLD MEDAL OF THE AMERICAN INSTITUTE OF THE CITY OF NEW YORK

A MODERN PIONEER

I am grateful for this opportunity to join with The American Institute of the City of New York in honoring one of our country's great pioneers, Dr. Frank Conrad.

America's early pioneers were men and women who had the vision to see, in the unknown wilderness of this continent, the secret of a better life. They had the faith and the courage to go and find it.

To-day, the frontiers of geography have almost vanished. The unexplored regions of the globe are few and far between.

But expanding civilization still calls—more loudly than ever before—for the pioneering spirit. To-day's objectives differ from those of a century ago, but they require no less the pioneering qualities of vision, faith and courage.

The modern pioneer explores, not the surface of seas and continents, but the unknown spaces that lie beyond the present frontiers of human knowledge. He grapples with the secret forces of the universe. He blazes a trail of experiment and invention into the boundless wilderness of our ignorance, and converts it bit by bit into a fertile land of useful knowledge and service.

Such a pioneer is Dr. Frank Conrad, to whom we are glad to pay our respects this evening.

Shortly after the end of the World War, Dr. Conrad, who had been in charge of earlier research in radiotelephony for the Westinghouse Electric and Manufacturing Company at Pittsburgh, decided to resume his work in this field. He had two experimental stations—one in the plant and one in his home four or five miles away. That was an ideal set-up for a modern pioneer: he could work all day at one place, and all night at the other.

In April, 1920, Dr. Conrad began sending out experimental broadcasts. He would talk into the microphone and then, for a rest, would play phonograph records. His broadcasts began to attract attention around Pittsburgh, and stimulated the sale of radio parts to home-set builders; so much so, in fact, that business executives of his company authorized him to build a new radio-telephone transmitter, which was completed in the fall of 1920.

The broadcast of the Harding-Cox election returns over the Westinghouse Station KDKA in Pittsburgh made history. That event, on November 2, 1920, is now universally regarded as the birth of public radio broadcasting. In a short time, other broadcasting stations sprang up in all sections of the country. A new and powerful medium for the instantaneous dissemination of culture, entertainment, information and news to all people was thus born, and a new American industry was launched.

Although it was the 1920 election broadcast which chiefly made the name of Frank Conrad known to the public, he has made many contributions of basic importance to radio. Time does not permit me to mention them all. I am told that he has more than 140 patents to his credit, and they are by no means confined to radio.

His inventions relate to electrical meters and instruments, dynamo-electric machines, vehicle lighting circuits, mercury arc current-rectifiers and power distribution systems. They touch the entire field of radio in the realm of both long and short waves. He has also made important inventions relating to motion picture apparatus.

In the early days, Dr. Conrad did not share the viewpoint of some other engineers, who looked on radio as something strange and apart from other electrical phenomena. He refused to regard radio as a mystery. To him it was just an interesting new kind of problem connected with alternating currents. Like all great pioneers, Dr. Conrad possesses a lively bump of curiosity and an unwillingness to take things for granted.

In the early twenties, an associate of Dr. Conrad returned from a radio conference in Washington, and told how the amateur operators of that day objected to being forced down into the "sewer waves." "What are the sewer waves?" asked Dr. Conrad. He was told that the waves shorter than 200 meters were regarded as useless, and "down in the sewer." "What is wrong with them?" he asked. He was given reasons why they wouldn't work, and, characteristically, he simply refused to accept the explanation. He convinced his associates that a theory based upon spark transmitters, then in general use, did not necessarily hold true with regard to vacuum tube transmitters, whose development later made the older system of spark transmission obsolete.

That early associate of Dr. Conrad is also present with us this evening. He is Charles W. Horn, a former Westinghouse employee and now an official of the National Broadcasting Company. Later in the evening he will demonstrate to those present in this room what the "sewer waves" are doing for us in the year 1940.

Practically all point-to-point radio communication and all international broadcasting are now conducted in this short-wave area of the radio spectrum. The development of short waves for practical use led radio research men to probe deeper and deeper into the mysteries of radio-wave propagation in the higher frequencies. Many new developments, the most outstanding of which are radio facsimile and electronic television, have come out of these studies. Many more are yet to come.

We occasionally hear it said that modern invention has gone too far, that it has created economic and social problems—especially unemployment—and that these can not be solved unless research is stopped. None of us wants to see men of Dr. Conrad's type plowed under, so this occasion is surely an appropriate one on which to condemn this defeatist attitude toward invention.

If American industrial history proves anything, it proves that invention has created many more new jobs than have been taken away by technological improvements or labor-saving devices.

Radio, for example, is purely a child of invention. To-day the radio industry, which practically did not exist twenty years ago, provides direct employment for 400,000 persons. Their annual wages reach an estimated total of half a billion dollars. Indirectly, radio provides employment for many thousands more.

Radio has now added sight to the service of sound. Television is here. It might more accurately be called "radiovision." It promises to add a brilliant new chapter to the annals of American economic development, and ultimately to provide new channels of employment for workmen and white-collar men, artists and writers, technicians and scientists.

The United States was created by pioneers. It was made great by other pioneers. As long as the pioneering spirit lives, America will go forward.

Dr. Frank Conrad is an illustrious example of this pioneering spirit. Difficult problems, that were a stop signal to others, were to him only a green light. Of him it may truly be said, that:

He didn't know it couldn't be done,
so he did it.

Mr. President, I have the great privilege to present to you, for the high honor of the Gold Medal of the American Institute of the City of New York, one of America's true pioneers; a man respected and admired throughout the electrical and radio industries, a benefactor of humanity and my friend—Dr. Frank Conrad.

David Sarnoff,
President of the Radio Corporation of America

THE STORY OF SHORT WAVES

Mr. Chairman and ladies and gentlemen, I deeply appreciate the honor extended by the American Institute of the City of New York in awarding me the institute's medal. I am particularly gratified that the award was determined in part by work in the development of radio broadcasting.

Radio broadcasting may justly be classed among the developments which have done most to produce our present civilization. The important ones, as I see them and in the order in which they came into the world, are printing, the railroad, the telephone, the automobile and the radio. Each of these developments has moulded the lives of people and changed the destinies of nations by facilitating the interchange of goods or ideas.

In the forefront of these agencies for the extension of civilized thought and action is radio broadcasting, a development so recent that even to-day it is no older than the average college sophomore. Ultimately, it should be a mighty weapon for peace, but paradoxically, it was literally born of the last World War. One of the factors which made it possible for science to have ready nearly all the tools required for this entirely new art was that war.

Before the struggle began, radio was considered as a possible rival of the telephone or telegraph wire, and its apparent field of greatest use was in communication from ship-to-shore, vessel to vessel or with isolated spots. The desirability of communication between ships for even limited distances served as an impetus to the development of devices which would thus enable a ship in distress to call for help. The apparatus as developed before the war period effectively served this purpose, although it would not make possible the use to which radio is put to-day. The military necessities of war time not only furnished the incentive for a further development of radio, but, what was even more important, it furnished the necessary financial support of this work.

At the close of the war, we found ourselves in possession of the radio products of many research agencies but with no apparent use to which to put these products. The tools were there, but so far as the world could see, there was no new work for them to perform. In my own case it was undoubtedly the natural fascination of working with a new tool that induced me to continue my research and experimentation.

To-day we all know that radio has come far and fast since those war days. Broadcasting—and particularly short-wave broadcasting—is developing so rapidly that it is hardly safe to make predictions as to its future, lest the prophecies become matter-of-fact realities before they appear in print.

However, with a background of more than 20 years' relationship with radio, I am convinced that if radio broadcasting is to continue to expand, and I have no doubt that it is, then the short wave-lengths offer the only road to that expansion. Two developments in the use of short-wave bands for a wider dissemination of entertainment and culture appear to be imminent at this time: first, a network of short-wave broadcasting stations; second, within a matter of ever-shortening time the ultra-short wave bands will be carrying television.

These forecasts are conservative, even "tame," compared with a few made by the late H. P. Davis, vice-president of the Westinghouse Electric and Manufacturing Company, a few months after the first scheduled commercial broadcast was made over station KDKA in 1920. Mr. Davis said:

The importance of reaching such tremendous numbers of people, with practically no effort, offers great possibilities for advertising and the distribution of news and important facts, and in reality introduces a "universal speaking service." It is not unreasonable to predict that the time will come when almost every home will include in its furnishings some sort of loudspeaking radio-receiving instrument, which can be put into operation at will, permitting the householder to be in more or less constant touch with the outside world through these broadcasting agencies.

And where will it end? What are the limitations? Who dares to predict? Relays will permit one station to pass its message on to another, and we may easily expect to hear in an outlying farm in Maine some great artist singing into a microphone many thousand miles away.

All these things were visions 20 years ago; to-day they are dreams made real by radio. And for all practical entertainment purposes, channels assigned to commercial broadcasting have proved adequate until today. Now these longer wave bands have reached their saturation point; there is virtually no more room in them to carry additional broadcast loads. Consequently, the short-wave bands are receiving more and more attention. There is ample room on these bands for expansion of broadcasting. What is more, these short waves are the long distance carriers of radio.

We began to realize this fact as early as 1922. We felt even then that there were wonderful possibilities which were being overlooked in the then unused and rather despised short-wave bands—bands considerably lower than those then in use for broadcasting and for communication. I arranged to carry on experimental short-wave tests from my home transmitter to an amateur station in Boston. The accident of selecting a collaborator as far from Pittsburgh as Boston was a happy one, because it automatically eliminated the so-called skip zone obstacle.

In the fall of 1923 Westinghouse located a re-broadcasting station in Hastings, Nebraska, the start of the well-known KFKX. At this point short-wave transmissions from KDKA were nightly received and re-broadcast on the station's assigned wave-lengths. But strangely enough, even while this re-broadcasting service was being carried out, radio men in general were convinced that the short-wave signals died out after traveling a relatively few miles. They did not know —and this is one of the things we demonstrated in our Pittsburgh-Boston tests—that this phenomenon is due to the skip zone near the transmitter and that the short-wave signals again appear at distances beyond the skip zone.

At a conference of associated radio companies held in London, England, in the early 1920's, delegates, in discussing a proposed radio link with South America, raised some questions as to short waves ever being of any value in radio. So one night I invited a number of the delegates to my room, where I unpacked a short-wave receiver I had taken with me from Pittsburgh. Tying a wire to a curtain rod for an aerial, I "tuned in" on our station 8XK at Pittsburgh and the Pittsburgh announcer launched a prearranged program. He spoke a few words and then relayed by telegraph code extracts from a Pittsburgh newspaper. Dave Sarnoff was in our room, and he deciphered the coded broadcast. The delegates were hearing not only their first transatlantic short-wave transmission, but also the greatest number of words sent over the ocean by radio up to that time.

On New Year's Eve in 1923, through previous arrangement, we transmitted a short-wave program from Pittsburgh to Great Britain. This program was re-broadcast to British listeners through a station operated by the Metropolitan Vickers Company at Manchester, England, and was the first internationally broadcast program as well as the first to be rebroadcast.

On December 12, 1924, KDKA's short-wave program was received and re-transmitted in Johannesburg, South Africa, and a few weeks later we transmitted a program to Australia. This transmission marked the ultimate in distance transmission since it was sent halfway round the world.

Then to the far north went these short waves, carrying messages and entertainment to the Royal Canadian Mounted Police; radio had begun its mission of carrying good-will to all the world.

Since those rather crude beginnings, the technique of short-wave broadcasting has advanced daily. To-day every nation in Europe displays a keen appreciation of the importance of short-wave transmission in inter-country mass communication. The short wave knows no borders and passes freely from one country to the other. Some nations are using this method to spread their particular ideologies and their pet brands of war propaganda, it is true; but the day will come when short waves will find their rightful use as bonds of international understanding and appreciation.

England links the vast British Empire with such a short-wave bond. The United States has for a number of years been making its South American neighbors better acquainted with it by means of short-wave broadcasts.

And while we are prophesying, who knows but that the day may come when the short wave will bring forth a new and better understanding between the great nations of the earth.

FRANK CONRAD,
Assistant Chief Engineer of the Westinghouse Electric and Manufacturing Company

OBITUARY

FREDERIC SCHILLER LEE

Frederic Schiller Lee was born at Canton, N. Y., on June 16, 1859, son of the Reverend John Stebbins Lee, president of St. Lawrence University. He received his A.B. degree at St. Lawrence in 1878 and his master's degree three years later. He then became a graduate student at the Johns Hopkins University, where he received the degree of Ph.D. in 1885.

The year 1885–86 he spent in Ludwig's laboratory at Leipzig among a group of students, many of whom became distinguished physiologists. Perhaps the best known of this group was the late Ivan P. Pavlov. It was in Ludwig's laboratory that Lee investigated the progressive increase in strength of contraction of an isolated muscle under constant stimulus during the first few contractions and showed this to be an effect of the same chemical substances which ultimately in higher concentration lead to the phenomenon of fatigue. Here also he become interested in electrophysiology and in the functions of the labyrinth.

Returning to America, he was instructor in biology at St. Lawrence for a year and then went to Bryn Mawr as instructor in histology and physiology.

In 1891 John G. Curtis, then professor of physiology at Columbia University, College of Physicians and Surgeons, brought Dr. Lee to Columbia as demonstrator in physiology. At that time the teaching of physiology in America had been by lecture and demonstration alone except at Johns Hopkins. With equipment which had been purchased in Leipzig by Dr. Curtis, supplemented by the work of the laboratory mechanician, Dr. Lee inaugurated a course of practical laboratory instruction for students. He became adjunct professor in 1895, professor in 1904 and Dalton professor and executive officer of the department in 1911. Resigning the latter post in 1920, he was research professor until 1928 and professor from 1928 to June 30, 1938, when he retired. He became professor emeritus on the following day, July 1, 1938.

Dr. Lee's major activity has been the study of fatigue. He developed a beautiful technique for this work, and his published curves are models of technical perfection in this field. His interest in the special problem of fatigue in isolated muscle led to studies in the general problem of fatigue, and he was a guiding spirit and active participant in the extensive investigations of the New York Commission on Ventilation. During the World War he was active in studies of the relation of working conditions and fatigue to production in industry. From 1917 to 1919 he was consulting physiologist to the U. S. Public Health Service. From 1919 to 1924 he was senior physiologist to the U. S. Public Health Service with special mission to investigate industrial conditions in Europe.

In 1911 Dr. Lee delivered the Morris K. Jesup Lectures at Columbia and in 1918 he was Cutter Lecturer at Harvard. He was secretary and treasurer of the American Physiological Society for ten years and president from 1917 to 1919. Besides membership in many professional societies, Dr. Lee's extra-mural activities covered a wide field. He was a member of the board of managers of the New York Botanical Garden for twenty-four years, vice-president for two years and president for four years. He was a member of the board of directors of the Desert Sanatorium at Tucson, Arizona, and trustee of the Columbia University Press.

For a number of years prior to the beginning of the long illness which terminated his life, Dr. Lee had been at work on a monograph covering the history of the study of fatigue from the most ancient records available to the present time. It is unfortunate that this work could not have been completed.

His knowledge of the literature of physiology was broad, and he could usually provide references to any important work from his unaided memory with sufficient precision to enable an inquirer to locate the work without delay.

His intimate friends will remember him as a genial and polished gentleman who derived exceptional pleasure from those social occasions in which the delightfully human side of his personality could manifest itself. His death, which occurred on December 14, 1939, followed an illness of several years. He was buried at Woodstock, Vermont, where for a long time he had made his home during the summer.

Horatio B. Williams

Columbia University

ALFRED GEORGE JACQUES

A promising career was terminated by the drowning of Alfred George Jacques in Bermuda on February 20, 1939. He is survived by his wife, Mrs. Hazel Lewis Jacques, and daughter, Fleur Frances Jacques.

He was born in Sutton, Surrey, England, on April 18, 1896. He attended the University of Western Ontario, Queens University, Lafayette College, the University of Manitoba and Harvard University, from which he received the degree of Ph.D. in chemistry in 1931. He was assistant in general physiology in the Rockefeller Institute for Medical Research from 1926 to the time of his death. From 1926 to 1933 he worked at the laboratory maintained by the Rockefeller Institute in Bermuda, and in subsequent years he made annual visits to the Bermuda Biological Station to continue his investigations.

These investigations dealt with certain large multinucleate plant cells which offer special advantages for studying the entrance and exit of substances and ascertaining the nature of the protoplasmic surface. They include the marine plants *Valonia* and *Halicystis* and the fresh-water *Nitella*. They consist of a thin layer of protoplasm, outside which is a cellulose wall and inside which is a clear watery sap which can be obtained with little or no contamination in sufficient quantity for chemical analysis.

In earlier papers he collaborated in showing that the inner and outer surfaces of the thin layer of protoplasm are quite different electrically and in their resistance to poisons, and that the protoplasm as a whole is very permeable to carbon dioxide and to hydrogen sulfide.

He found later that the passage of sodium iodide through the protoplasm was a million times slower than through an aqueous layer of the same thickness. This appears to be due to the non-aqueous layers at the inner and outer surfaces of the protoplasm. These are too thin to be visible, but nevertheless they succeed in delaying the entrance of certain electrolytes to an extraordinary degree, apparently owing to the very slight solubility of these substances in the non-aqueous material forming the surface layers.

Such differences in solubility might explain why potassium is absorbed much more rapidly than sodium in *Valonia*. It had been suggested that these substances enter chiefly as hydrates by combining with an acid HX produced by the protoplasm and a mathematical treatment of absorption had been developed along these lines. This was carried further by Jacques, who showed, on theoretical grounds, that the effect of external pH on absorption may be large or small, depending on the dissociation constant of HX.

This may account for the fact that in *Nitella* the entrance of potassium is not increased by raising the external pH. Here the rate of entrance is not affected by light. This would be expected if light acts chiefly by raising the external pH through photosynthesis. In *Valonia* where higher external pH increases, the entrance of potassium light also increases it.

In view of the avidity with which potassium is taken up by *Valonia* it may seem surprising that it can be driven out of the cell by ammonia without causing injury. The behavior of ammonia was extensively studied by Jacques and subjected to mathematical analysis. On theoretical grounds he was able to offer an explanation for the fact that the undissociated ammonia in the sap remains less than in the external solution. He showed that the accumulated ammonia can be removed from the cell, but that this process involves a considerable latent period since the ammonia does not begin to come out at once when the cell is placed in ammonia-free sea water. Both the intake and exit of ammonia are hastened by light.

Cells from which the ammonia has been removed can take it up and again lose it under suitable conditions.

He also found accumulation of certain anions. In both *Valonia* and *Halicystis* iodide is taken up from the sea water and appears as iodide in the sap. This is of interest in connection with the function of the thyroid. The internal concentration of iodide exceeds the external 1,000 times in *Halicystis* and 40 times in *Valonia*. Likewise the internal concentration of nitrate exceeds the external 500 times in *Halicystis* and 2,000 times in *Valonia*.

His most recent experiments were of a novel nature. It seemed possible that the growth of plant cells is inhibited by the cellulose wall which must be stretched by the entering water before the volume of the cell can increase. If this inhibition could be removed the cell might expand more rapidly. He was able to bring this about by impaling cells of *Valonia* and *Halicystis* on glass capillaries on which they live for weeks.

As the entrance of water is no longer hindered by the cellulose wall the volume of the sap increases 10 to 20 times as fast as in normal cells. The entrance of electrolyte keeps pace with that of water so that the composition of the sap remains approximately constant.

The entrance of water proceeds faster in light, and in *Halicystis* it is not affected by changes in external pH.

The entrance of water into impaled cells of *Halicystis* increases proportionally as the sea water is diluted, and the protoplasm does not appear to be injured until the amount of added water equals that of the sea water.

In all his work he was chiefly concerned with the kinetics of absorption, and he developed a mathematical treatment dealing with all the details of the process.

In connection with his studies on the absorption of potassium he became interested in its isotopes. Samples of *Valonia* sap and of sea water were sent to Dr. A. Keith Brewer, who reported that the protoplasm of *Valonia* is able to distinguish between the isotopes in that it takes up K^{41} in preference to K^{39}.

This brief, incomplete account makes it evident that his interest lay in fundamental questions. These he attacked in thorough and critical fashion. Technical difficulties were overcome with surprising ease. Chemical and biological problems were equally stimulating to his imagination. He represented a rare synthesis of both disciplines. His contributions have abiding value.

W. J. V. OSTERHOUT

RECENT DEATHS AND MEMORIALS

Dr. Alviso Burdett Stevens, until his retirement in 1919 dean of the College of Pharmacy of the University of Michigan, died on January 24 in his eighty-seventh year.

S. L. Simmering, professor of mechanical engineering and head of the department at the University of Colorado, died on January 27 at the age of fifty-five years.

Dr. Sherman L. Davis, for thirty-five years professor of chemistry at Indiana University, died on February 1. He was seventy-five years old.

Dr. Charles Augustus Strong, professor of psychology at Columbia University from 1902 to 1912, died at Fiesoli, Italy, on January 23 at the age of seventy-seven years.

Dr. Edward Gleason Spaulding, McCosh professor of philosophy at Princeton University, died on January 31. He was sixty-six years old.

Dr. Priscilla Avery, cytologist at the Botanical Garden of the University of California at Berkeley, died on December 29. She was forty years of age, and had been a member of the staff for twelve years.

Professor Sir Gilbert Thomas Morgan, who has been since 1925 director of the chemical research laboratory at Teddington of the British Department of Scientific and Industrial Research, died on February 1 at the age of sixty-nine years.

Professor Hans Horst Meyer, until his retirement in 1924 professor of pharmacology at the University of Vienna, died on October 8 at the age of eighty-six years. On his seventieth birthday the Vienna Academy of Sciences established the Hans Horst Meyer prize, which is awarded every five years for "research in the German language in the field of experimental medicine."

On the afternoon of January 30 there was held at the New York Academy of Medicine a memorial meeting in honor of the late Dr. Livingston Farrand. This meeting was held under the auspices of the many organizations with which Dr. Farrand was associated. The speakers were: Dr. Charles F. W. McClure, of Princeton, representing the class of 1888, of which Dr. Farrand was a member; Dr. Charles J. Hatfield, representing the National Tuberculosis Association; Homer Folks, representing the Rockefeller Tuberculosis Commission in France; Eliot Wadsworth, representing the American Red Cross; Dr. Albert R. Mann, representing Cornell University; Dr. James Ewing, representing Cornell University Medical College; Albert G. Milbank, representing the Milbank Memorial Fund, whose address was read by Frank G. Boudreau; Dr. Thomas Parran, representing the United States Public Health Service; Dr. Simon Flexner, representing the Public Health Council of the State of New York; Barklie Henry, representing the New York Hospital, and Dr. George E. Vincent, representing the Rockefeller Foundation.

SCIENTIFIC EVENTS

ANNUAL REPORT OF THE DIRECTOR OF THE NEW YORK BOTANICAL GARDEN

The second annual report of Dr. William J. Robbins, director of the New York Botanical Garden, was presented to the Board of Managers and to the corporation on January 8. He stated that the herbarium of the garden had grown to 1,963,238 specimens, an increase of 30,000 over last year, all of them catalogued and filed for ready reference. The library had added nearly a thousand books in the past year, attendance at courses and lectures was greatly increased, publications of the garden had a much wider sale and distribution than ever before, and other facilities for the scholastic use of the garden had been developed.

Emphasis in the report was put on the place of the Botanical Garden in the life of the City of New York. Dr. Robbins writes:

> The garden is a symbol of peace and orderliness and a place of relaxation in a busy city. Its importance in this report is an intangible; it can not be weighed or measured; yet such intangibles are of great significance.
>
> For the garden to act effectively as a place of recreation and a symbol of peace necessitates having attractive and varied plantings indoors and out, placed in suitable settings, and arranged with due regard for the convenience and comfort of the public.
>
> Progress toward this end has been made during 1939. Old plantings, such as the borders of annuals and perennials, dahlias, chrysanthemums and irises, have been maintained in good condition, and new ones—for example, a cherry walk and a lilac walk—have been installed. Material additions have been made to the arboretum (the collection of trees and shrubs now number 2,025 different kinds), and several hundred rhododendrons—gifts from nurseries—have been planted. Parts of the main conservatories have been replanted and re-arranged. The winter flower shows, lasting from November through May, have been continued. For these, last year 8,686 pots of plants were used, representing 573 species and varieties.

In speaking of the Tropical Flower Garden, which was opened with a special ceremony last November, Dr. Robbins told of some of the work that lay behind the planting out of the hundreds of plants of 225 varieties in this one unit of the greenhouse. Sixtyeight truck-loads of soil, sand, cinders, leaf-mold and manure were brought in, besides six tons of rock and 1,000 square feet of dressed flagstone for walks.

The science course for professional gardeners is serving as a model for similar courses in distant cities. The Montreal Botanical Garden and the Golden Gate Park in San Francisco are now opening courses based on the one in New York, and one of the graduates of the garden is directing a course in horticulture at Dillard University in New Orleans.

The two-year course in practical gardening, the first graduation exercises of which will be held next June, has had an attendance of a hundred students. A new course in the identification of plants in the vicinity of New York was started during the year. It is planned especially for teachers and nature-study leaders.

At the close of his report, Dr. Robbins expressed appreciation for the work performed by the Works Progress Administration during the year. In addition to the extensive outside labor provided, the WPA has given the garden invaluable assistance in the herbarium, library, laboratory and elsewhere, doing mounting, filing, indexing, book-binding, typing, writing of labels and serving as research assistants.

ENLARGEMENT OF THE CHEMISTRY BUILDING OF THE UNIVERSITY OF CINCINNATI

THE new addition to the Chemistry Building at the University of Cincinnati was dedicated with appropriate ceremonies planned and conducted by student organizations on Friday, January 26. Addresses were made by Dr. Raymond Walters, president of the university, Dr. Robert C. Gowdy, dean of the College of Engineering and Commerce, and the guest of honor, Professor Alfred H. White, professor of chemical engineering at the University of Michigan.

The addition, which was built at a cost of $500,000, more than doubles the size of the old building to which it is joined and contains lecture room space for 1,500 students at one time. Most of the added space has been used for expansion by the departments of liberal arts, chemistry and chemical engineering. The remainder is for the present occupied by the department of mathematics of the College of Engineering and Commerce.

Existing laboratories have been increased in size about 50 per cent., and entirely new facilities have been provided for the work in unit operations, engineering research, metallurgy, industrial bacteriology and optico-chemistry of the rapidly growing department of chemical engineering. There is also an auditorium seating four hundred, which is well equipped for lectures, demonstrations and sound movies. Construction was made possible through a municipal bond issue and a P.W.A. grant.

OFFICERS OF THE WASHINGTON ACADEMY OF SCIENCES

AT the forty-second annual meeting of the Washington Academy of Sciences on January 18, the election of the following officers was announced: *President,* E. C. Crittenden, Bureau of Standards; *Corresponding secretary,* F. D. Rossini, Bureau of Standards; *Recording secretary,* F. C. Kracek, Geophysical Laboratory; *Treasurer,* H. S. Rappleye, Coast and Geodetic Survey; *Non-resident vice-presidents,* P. G. Agnew, American Standards Association, and Gifford Pinchot, Milford, Pa.; *Members of the Board of Managers* for 3 years, J. F. Couch, Bureau of Animal Industry, and J. E. Graf, Smithsonian Institution.

Resident vice-presidents, nominated by each affiliated society to represent it on the Board of Managers, were elected as follows: *Philosophical,* R. E. Gibson, Geophysical Laboratory; *Anthropological,* Frank M. Setzler, U. S. National Museum; *Biological,* W. B. Bell, Biological Survey; *Chemical,* A. T. McPherson, Bureau of Standards; *Entomological,* A. H. Clark, Smithsonian Institution; *National Geographic,* A. Wetmore, Smithsonian Institution; *Medical,* Fred O. Coe, 1835 Eye Street, N.W.; *Historical,* Allen C. Clark, 816 14th Street, N.W.; *Botanical,* Charles Thom, Bureau of Plant Industry; *Archeological,* Aleš Hrdlička, Smithsonian Institution; *Foresters,* W. A. Dayton, Forest Service; *Washington Engineers,* P. C. Whitney, Coast and Geodetic Survey; *Electrical Engineers,* H. L. Curtis, Bureau of Standards; *Mechanical Engineers,* Walter Ramberg, Bureau of Standards; *Helminthological,* E. W. Price, Bureau of Animal Industry; *Bacteriological,* R. R. Spencer, National Institute of Health; *Military Engineers,* C. L. Garner, Coast and Geodetic Survey; *Radio Engineers,* H. G. Dorsey, Coast and Geodetic Survey.

THE SUMMER MEETINGS OF BOTANISTS

THE 1940 summer meetings of the American Association for the Advancement of Science and affiliated societies will be held at the University of Washington, in Seattle, Washington, from June 17 to 22, inclusive. The Pacific Section of the Botanical Society of America will meet at the same time and place as one of the affiliated societies, and will arrange a program in cooperation with the Botanical Society of America and with Section G of the American Association for the Advancement of Science.

Opportunities will be given for members of the Botanical Society of America, whether living in the Pacific Section or elsewhere, to present papers during the meetings. Any member of the Botanical Society who plans to attend the meetings at Seattle and who wishes to present a paper should send the title of the paper, an abstract of not over two hundred words, the time required for presentation and a request for a projector in case slides are to be used, to Ira L. Wiggins, secretary-treasurer of the Pacific Section. The maximum time allowed for presentation of a contributed paper will be fifteen minutes, and authors are requested to make serious efforts to hold their papers to such lengths that they can be presented in ten minutes or less.

All titles and abstracts of papers must be in the hands of the secretary not later than May 1. Those arriving after that date can not be included in the printed program.

An excursion to the Friday Harbor Marine Station of the University of Washington is being planned by the Botanical Society and by the American Society of Plant Physiologists on the final day of the meetings. Possibly a second excursion, to the Olympic Peninsula, will be arranged for those whose interests are concerned with flowering plants rather than with marine organisms. A fuller announcement concerning the excursions will be made later.

IRA L. WIGGINS,
Secretary-Treasurer, Pacific Section of the Botanical Society of America
STANFORD UNIVERSITY, CALIF.

THE AMERICAN CHEMICAL SOCIETY AND DR. SPRINGER

MORE than 3,500 chemists will convene in Cincinnati for the ninety-ninth meeting of the American Chemical Society, which will meet from April 8 to 12 under the auspices of the Cincinnati section. Sessions will be held by seventeen of the divisions. Dr. Alfred Springer, dean of Cincinnati chemists, who on February 12 will celebrate his eighty-sixth birthday, has been appointed honorary chairman of the meeting. Proctor Thomson, head of the Standards Department of the Chemical Division of the Procter and Gamble Company, will be general chairman.

Dr. Springer is known for his work on fermentation and for his inventions of the torsion balance, widely used in pharmacy, and for aluminum sounding boards for musical instruments. For fifty-seven years, until his retirement in 1930, he was the owner of the chemical firm of Alexander Fries and Brothers, founded in Cincinnati by his uncle. He promoted American forestry and stream purification movements, and was one of the founders of the American Forestry Congress in 1882. Dr. Springer was born in Cincinnati. He received the Ph.D. degree from the University of Heidelberg in Germany at the age of eighteen, studying under Bunsen and Kirchhoff. In 1931 the university conferred upon him, as the oldest surviving graduate holding the Ph.D., the honorary degree of doctor of natural science.

In 1879 a group of chemists at Dr. Springer's home organized the first local chemical society, which in 1892 became the Cincinnati Section of the American Chemical Society, of which he was chairman in 1892 and 1906. He is a fellow of the American Association for the Advancement of Science, of which he was general secretary in 1884 and vice-president in 1892, and a corresponding member of the British Association for the Advancement of Science. For the invention of the torsion balance, he received the John Scott Legacy premium and medal of the Franklin Institute in 1891.

The ten symposia planned for the meeting include discussions of the utilization of agricultural wastes, the combustion of solid fuels, the chemistry of insulation, cellulose plastics, sulfanilamide and related derivatives, sterols and lipoids, the application of mathematics to chemistry, fundamental chemical thermodynamics of hydrocarbons and their derivatives, phase transitions and the future of chemistry as a specialized science in the high-school curriculum. Industrial research will be emphasized in the discussions.

Convention headquarters will be at the Netherland Plaza Hotel, where registration will begin on Sunday, April 7. Sessions of the divisions will be held at the Netherland Plaza, Gibson and Sinton Hotels.

SCIENTIFIC NOTES AND NEWS

DR. FREDERICK H. SEARES, astronomer and assistant director of the Mount Wilson Observatory of the Carnegie Institution of Washington, was awarded the Catherine Wolfe Bruce Gold Medal "for distinguished services to astronomy" at the annual meeting of the Astronomical Society of the Pacific, which was held on January 27 in San Francisco.

DR. FRANK CONRAD, of Pittsburgh, assistant chief engineer of the Westinghouse Electric and Manufacturing Company, was presented with the 1940 Gold Medal of the American Institute of the City of New York for pioneer work in radio broadcasting at the annual dinner of the institute on the evening of January 28. The annual fellowship was presented to William L. Laurence, science news reporter of *The New York Times*. Dr. Conrad was presented for the medal by Dr. David Sarnoff, president of the Radio Corporation of America, and Mr. Laurence was presented for the fellowship by Dr. Oscar Riddle, of the Station for Experimental Evolution at Cold Spring Harbor. Robert T. Pollock, president of the institute, presided and presented the medals. The addresses made on this occasion by Dr. Sarnoff and Dr. Conrad appear in the present issue of SCIENCE.

THE ALFRED NOBLE PRIZE, consisting of the sum of $500 and a certificate, given annually to a young engineer not over thirty years of age "for a technical paper of particular merit," was presented on January 23 at the annual winter convention of the American Institute of Electrical Engineers to Claude E. Shannon, assistant in mathematics at the Massachusetts Institute of Technology, for his paper entitled "A Symbolic Analysis of Relay and Switching Circuits." Mr. Shannon will reach the age of twenty-four years in April, being the youngest of those who have so far won the prize.

THE 1939 Lawrence Sperry Award of the Institute of the Aeronautical Sciences has been given to Charles M. Kearns, Jr., research engineer for the Hamilton Standard Propellers division of the United Aircraft Corporation at East Hartford, in recognition of his work in the "successful application of methods of measuring propeller vibration stresses in flight." Mr. Kearns received the certificate of award and the $250 cash prize on January 26 at the honors night and annual dinner of the institute.

A RECEPTION at the Neurological Institute, a unit of the Columbia-Presbyterian Medical Center, was given on January 17 in honor of Dr. Tracy J. Putnam, who was recently appointed professor of neurology and neurosurgery at the College of Physicians and Surgeons and director of neurological and neurosurgical services at the institute. Before going to Columbia Dr. Putnam was professor of neurology at the Harvard Medical School and neurologist in chief of the Boston City Hospital.

OFFICERS of the Association of Land Grant Colleges and Universities elected at the Washington meeting are: Dr. F. D. Farrell, president of the Kansas State College and director of the Experiment Station, promoted from the vice-presidency to the presidency, Dr. W. C. Coffey, dean of the department of agriculture of the University of Minnesota, becoming vice-president and Dr. Thomas P. Cooper, dean of the College of Agriculture of the University of Kentucky and director of the Experiment Station, continuing as secretary-treasurer. Dr. Thomas B. Symons, extension director of the University of Maryland, succeeds Dr. R. G. Bressler, president of Rhode Island State College, on the executive committee.

PRESIDENT CHARLES SEYMOUR, of Yale University, was elected at a meeting held on January 18 to membership on the board of trustees of the American Geographical Society of New York. Officers of the society reelected were: *President,* Roland L. Redmond; *Vice-president and chairman of the council,* W. Redmond Cross; *Recording secretary,* Hamilton Fish Kean, and *Treasurer,* Henry Parish.

DR. CHARLES PALACHE, professor of mineralogy and curator of the Mineralogical Museum of Harvard University, with which he has been connected since 1896, will retire next September with the title professor of mineralogy emeritus. His colleagues and former students held a reception in his honor on February 5 at the Harvard Faculty Club. A portrait of Dr. Palache, by Irwin Hoffman, of New York, was presented to the university; it will hang in the Mineralogical Museum.

PROFESSOR GEORGE WASHINGTON PIERCE has retired with the title emeritus after serving for forty years on the faculty of Harvard University. Dr. Pierce became Rumford professor of physics in 1921 and Gordon McKay professor of communication engineering in 1935. He has been director of the Cruft Laboratory since 1914.

DR. CHARLES CASSEDY BASS, since 1912 professor of experimental medicine and for the past eighteen years dean of the School of Medicine of Tulane University, retired on February 4. He is succeeded by Dr. Maxwell Edward Lapham.

DR. JAMES G. NEEDHAM, until his retirement with the title emeritus in 1936 professor of entomology and limnologist at Cornell University, has been appointed for the second semester visiting professor of biology in the University of Puerto Rico. His address until May 28 will be the Department of Biology of the university at Rio Piedras, P. R.

DR. DANIEL C. ELKIN, professor of surgery at the School of Medicine of Emory University, Atlanta, has been named Joseph B. Whitehead professor of surgery, a position recently established under a grant of $250,000 from the Joseph B. Whitehead Foundation of Atlanta. Under the terms of the grant, the income will be expended to support both teaching and research activities in connection with the new professorship.

DR. KIMBALL YOUNG, professor of sociology and psychology at the University of Wisconsin, has been appointed professor of sociology at Queens College, Flushing, N. Y.

DR. ROLAND D. PARKS, associate professor of mining engineering at the Michigan College of Mining and Technology, has been appointed assistant professor of geology at the Massachusetts Institute of Technology. He will give special courses in mine evaluation, mineral economics and elements of mining.

DR. JAMES F. COUCH, who has been for more than twenty-two years a member of the staff of the Bureau of Animal Industry, Washington, D. C., has joined the new regional laboratory in Philadelphia.

DR. J. J. WILLAMAN, formerly connected with the Röhm and Haas Company, Philadelphia, has been appointed chief of the biochemical division of the Eastern Regional Laboratory of the U. S. Department of Agriculture of Wyndmoore, Pa.

DR. GEORGE R. HARRISON, professor of physics and director of the research laboratory at the Massachusetts Institute of Technology, has become editor of the *Journal of the Optical Society of America*. He succeeds the late Professor F. K. Richtmyer, of Cornell University. Dr. Arthur C. Hardy, professor of physics at the institute, has been appointed secretary of the Optical Society to take the place of Dr. L. B. Tuckerman, assistant chief of the Division of Mechanics and Sound of the National Bureau of Standards, who resigned in December.

DR. C. L. ALSBERG, director of the Giannini Foundation of Agricultural Economics of the University of California, has accepted an invitation to act as a member of the guiding committee of the section on economics and sociology of the eighth American Scientific Congress to be held in Washington, D. C., from May 10 to 18. The committee was appointed to formulate the program for this section and to manage its sessions during the congress.

DEAN WALTER C. COFFEY, of the department of agriculture of the University of Minnesota, has been elected chairman of the Board of Directors of the Minneapolis Federal Reserve Bank for the Ninth Federal Reserve District, which covers the States of Minnesota, North and South Dakota and parts of Wisconsin and Montana. He has been a member of the board for several years.

DR. FORREST F. HILL, professor of agricultural economics at Cornell University, who has had leave of absence to serve in Washington as governor of the Farm Credit Administration, presented his resignation on December 20 as a protest against an executive order which placed the Farm Credit Administration under the jurisdiction of the U. S. Department of Agriculture. He is returning to the university for the second term.

DEAN HAROLD S. DIEHL, of the Medical School of the University of Minnesota, has been appointed a member of the National Advisory Health Council of the United States Public Health Service. The primary function of this council is to advise with the Surgeon-General concerning the scientific and research work of the Public Health Service.

SEVERAL officers of the Carnegie Institution of Washington left on January 9 for a three weeks' trip to Guatemala to examine its research program there in volcanology and archeology. Included in the party were Dr. Vannevar Bush, president of the institution; Dr. Frank B. Jewett, Henry R. Shepley and Frederic C. Walcott, trustees; Dr. A. V. Kidder, chairman of the division of historical research, and Dr. L. H. Adams and Dr. F. E. Wright, of the Geophysical Laboratory.

DR. FRANS VERDOORN, formerly of Leyden, Holland, editor and general manager of *Chronica Botanica* and other international publications, has arrived in the United States, where he plans to continue his work. His library and collections have been transferred to this country. The International Addressbook of Plant Taxonomists has been completed and will be published shortly. Correspondence for the present should be addressed care of the Arnold Arboretum, Jamaica Plain, Mass.

DR. ENRICO FERMI, professor of physics at Columbia University, will be Hitchcock professor at the University of California at Berkeley during the spring semester. The general subject of his lectures will be "High Energies and Small Distances in Modern Physics." The titles of the separate lectures are: "Historical Review," "Elementary Particles," "Nuclear Disintegrations and Nuclear Chemistry," "Fast and Slow Neutrons," "Fission of Uranium" and "The Sources of Stellar Energy."

DR. REGINALD ALDWORTH DALY, Sturgis-Hooper professor of geology at Harvard University, spoke at the Louisiana State University on February 7. The title of the lecture was "New Light on the Earth's Interior," material for which is based on geophysical data gathered in Finland.

DR. ERNEST W. GOODPASTURE, professor of pathology at the School of Medicine of Vanderbilt University, delivered the Eastman Memorial lecture at the School of Medicine of the University of Rochester, N. Y., on December 12. His address was entitled "A Consideration of Pathogenesis in Virus and Bacterial Infections."

DR. GEORGE H. PARKER, of Harvard University, will give the William Keith Brooks lecture at Greensboro College on April 25. He will speak on "Modern Conceptions of the Action of the Nervous System."

DR. HOMER W. SMITH, professor of physiology at the New York University College of Medicine, will deliver the fifth Harvey Society Lecture of the current series at the New York Academy of Medicine on February 15. The title of his address will be "The Physiology of the Renal Circulation."

PROFESSOR JEAN DUFRENOY, of the University of Bordeaux, at present exchange-professor of plant physiology at Louisiana State University, lectured before the Sigma Xi Club of St. Louis University on January 16. The title of his lecture was "The Nature of the Vacuome and its Role in Biological Processes."

DR. ROBERT ROBINSON, Waynflete professor of chemistry at the University of Oxford, has accepted an invitation of the University of Pennsylvania to deliver an address during the celebration of the bicentennial of the university, which will be held from September 15 to September 21.

Nature states that a University of Poland Abroad was instituted at a meeting held in the Polish Library, Paris, on December 1.

IT has been decided that in view of the present world situation it is advisable to postpone to an indefinite date the fifth International Congress of Pediatrics, which was to have been held in Boston on September 3, 4 and 5.

THE American Institute of Nutrition will meet in New Orleans on March 13. The morning and afternoon sessions will be devoted to the presentation of papers on current nutrition research. The evening will be given over to a symposium on "Nutrition for the Higher Health," with Dr. Henry C. Sherman, Mitchill professor of chemistry at Columbia University, presiding. The separate papers to be presented are: "The Problems of Promoting Better Human Nutrition," Dr. E. V. McCollum; "The Assessment of the Nutrition of Populations," Dr. J. B. Youmans; "Dietary Levels in the United States," Hazel K. Stiebeling; "Pellagra and Associated Deficiency Diseases as a Medical and Public Health Problem," Dr. T. D. Spies.

APPLICATIONS to the National Research Council Committee for Research in Problems of Sex, for financial aid during the fiscal year beginning July 1, in support of the study of fundamental problems of sex and reproduction, should be received before April 1. They may be addressed to the chairman, Dr. Robert M. Yerkes, Yale School of Medicine, New Haven, Conn. Although investigations on hormones continue to command the interest and support of the committee, preference, in accordance with current policy, will ordinarily be given to proposals for the investigation of neurological, psychobiological and behavior problems.

OAKES AMES, research professor of botany at Harvard University and director of the botanical museum, has presented to the university his orchid herbarium of 57,000 specimens. Besides the herbarium he has given to the university his library of more than 1,800 volumes and pamphlets about orchids and has provided the sum of $68,000 to establish an endowed curatorship for the collection, which is to be known as the Orchid Herbarium of Oakes Ames.

DR. EDWARD BAUSCH, of the Bausch and Lomb Optical Company, Rochester, N. Y., has given his house and grounds to the Rochester Museum of Arts and Sciences, to become the nucleus of a division to be devoted to industrial science. Furthermore, he has pledged himself to build the first unit of the museum. The assessed valuation of the residence and grounds is $150,000. In making the gift Dr. Bausch in a letter to Dr. John R. Williams, the president of the museum, wrote: "It is only natural that I should have wished that we had a museum in my native city to round out the splendid cultural and educational facilities which it possesses, and I am happy to say that Mrs. Bausch shares this desire with me."

A WPA grant to Rutgers University has made it possible to begin the remodelling of an old house near the campus for the use of the department of psychology. Partitioning the house into twenty-one rooms will furnish space for laboratory, shop, clinic, offices, classrooms and seminar room, and a limited number of rooms for graduate students. Dr. Carroll C. Pratt is head of the department.

THE Hayden Planetarium of the American Museum of Natural History has acquired through the generosity of Lincoln Ellsworth a recently discovered specimen of an important meteorite fall. It is a complete specimen, weighing 522 pounds, and is part of the Bethany-Gibeon fall in Southwest Africa. It is the only one of the Gibeon group that has been brought whole to this country. The new meteorite, to be known as the Kirris-Ost siderite, will be added to the collection of meteorites.

A 225-POUND Brazilian topaz crystal, said to be one of the finest in the world, has been obtained by the Mineralogical Museum of Harvard University and has been placed on exhibit. The topaz is eighteen inches in diameter. It is white in color, with inclusions of dark manganese minerals distributed in parallel streaks.

DISCUSSION

AN ENDEMIC PALM ON COCOS ISLAND NEAR PANAMA MISTAKEN FOR THE COCONUT PALM

Two Cocos Islands sometimes are confused, one an inhabited coral group, known also as the Keeling Islands, located in the Indian Ocean south of Sumatra, the other an uninhabited mountainous island in the Pacific Ocean about 250 miles southwest of Panama, midway between the Galapagos Islands and Costa Rica. This small precipitous forest-covered island, rising to nearly 3,000 feet, chiefly known as a resort of buccaneers and treasure-seekers, was visited by Lionel Wafer in 1685 and described as abounding in coconut palms, not only near the landing place, later called Wafer Bay, but also "on the skirts of the hilly ground in the middle of the isle, and scattering in spots upon the sides of it."

This early report of the coconut palm in a wild state now is explained by the discovery of a large native palm, not known from the mainland and probably peculiar to Cocos Island, growing abundantly on the steep wooded slopes and having a notable resemblance to the coconut palm, although of a different family. The leaf-crowns emerge above the other trees and are readily visible from the anchorage, but the palms are not easily reached through the unbroken forest. The leaves are relatively broad and spreading like those of the coconut palm, with the pinnae regularly placed and gracefully drooping in the same manner, a truly "mimetic" similarity, except that the two palms would not be found in company, the coconut being strictly a sun palm, too intolerant of shade to grow in the forest.

The material for the study of the endemic palm was obtained in August, 1938, by Dr. Waldo L. Schmitt, of the United States National Museum, during the cruise of President Roosevelt on the *U. S. S. Houston.* The young men of the landing party cut down a mature palm in the forest and helped to bring back a generous series of specimens, including large sections of the trunk and leaves, entire inflorescences, seeds and seedlings, with numerous photographs. A detailed account of the new genus Rooseveltia has been published recently in Smithsonian Miscellaneous Collections, Vol. 98, No. 7, "A New Palm from Cocos Island Collected on the Presidential Cruise of 1938," with 26 plates, a few showing Plectis, the nearest related genus, discovered in the mountain forests of eastern Guatemala in 1902, but not previously illustrated.

Rooseveltia is a tall elegant palm with a massive columnar trunk attaining 60 feet and upward, a member of the royal palm family, like those known in the West Indies as mountain palms or mountain cabbage palms, a group notably specialized for forest conditions. The seedlings are graceful and erect, growing a foot high in the first year, with compound leaves, long cylindrical leaf-sheaths, slender filiform petioles and narrow symmetrical pinnae, the first leaf dividing with remarkable regularity into six pinnae, the second and third leaves usually into four or five pinnae. Only seven of the seedlings had six pinnae on all three leaves, of 477 plants that had reached the stage of being counted. The roots of the young plants are slender and wiry, holding the potting soil in a close network so that injury in transplanting may be avoided, this feature giving a better prospect of Rooseveltia thriving in conservatories or in sheltered gardens of southern Florida and other tropical regions.

The discovery of Rooseveltia in its bearing on the history of the coconut palm has relation to the problem of tracing the origin of civilization through the cultivated plants. The principal center of plant domestication was in South America, and the series of primitive cultures is more complete in that continent. Most of the "Old World" crop plants are so little changed that their wild relatives are readily recognized, while in America only remote and doubtful relatives have been found for several widely cultivated species. Thus an ancient domestication is indicated for the so-called "peach palm," *Guilielma speciosa,* a member of the coconut family with many seedless varieties among very primitive tribes of the upper Amazon Valley and neighboring regions, to Panama and Nicaragua.

Wafer's open narrative, with its vivid impression of wild coconuts growing freely on the wooded slopes of Cocos Island, often was quoted and undoubtedly contributed to the belief of many writers of the last century that the coconut palm originated in the Pacific Islands or in the Malay Archipelago, some even alleging a Spanish introduction to America. On botanical grounds an American origin of the coconut palm is rather definitely indicated, the several families of palms being remarkably localized. The coconut family is the dominant group of palms in South America, with specialized tribal and generic characters, and hundreds of wild species, but is not represented in the Old-World tropics. Even the so-called African oil palm, *Elaeis guineensis,* appears to have been introduced from Brazil to the early Portuguese settlements in West Africa, with maize and cassava, before it was brought to the West Indies.

The romantic theory elaborated by St. Pierre, of coconuts disseminated by ocean currents, seldom appears in modern text-books, but the East Indian origin still is asserted, as in a recent work: "The tree is a native of the Malay Archipelago, but it has been carried to tropical and subtropical regions in all parts of the world." The argument was that the islands must have been colonized from Asia, and that coconuts were indispensable. It is hard to lay aside the venerable belief in Asiatic antiquity.

The banana and the breadfruit no doubt were brought into Polynesia from the Malay region, where their wild relatives are found, but other crop plants appear to have come from America. The sweet potato reached all the Polynesian islands and kept its name "cumara," which still is used among Quichua-speaking natives of southern Peru, in the eastern valleys below Cuzco.[1] The general Polynesian name of the coconut, "niu," has not been recognized in America, but possibly is represented by "nyu," the word for milk in the Quichua language.

The mistake regarding the mountain palms of Cocos Island need not discredit Wafer's account of the large numbers of true coconut palms near the landing place.

[1] *Jour. Washington Acad. Sci.,* February 19 and June 4, 1916; SCIENCE, November 2, 1917.

These must have been planted in clearings and probably had not been abandoned for more than a century, or they would have been smothered by the forest. An earlier European settlement on Cocos Island seems improbable, but many islands off Panama were inhabited. Oviedo's account of the Isthmus, written in the time of Balboa and published in 1526, leaves no doubt that coconuts were abundant on the Pacific coast.

O. F. COOK

U. S. DEPARTMENT OF AGRICULTURE

MOMENTUM AND ENERGY

IN a note in SCIENCE (January 12, 1940, p. 43) Dr. Heyl discusses the seventeenth century dispute over momentum and energy, and compares it with the present dual points of view regarding what might be called wave-electricity and particle-electricity.

The difference between the momentum and energy effects of force is no more than a difference in point of view. The energy aspect is represented by the equation

$$2\int_1^2 F\,v\,dt = m(v_2^2 - v_1^2)$$

where F, in the direction of v, is the force on the mass m. For simplicity assume rectilinear motion.

If this statement represents a law it should be independent of the velocity of the observer. Let him move at constant velocity c relative to the laboratory in which the law is being checked experimentally. The moving observer will therefore use the equation

$$2\int_1^2 F(v+c)\,dt = m\{(v_2+c)^2 - (v_1+c)^2\}$$

which reduces to the momentum law

$$\int_1^2 F\,dt = m(v_2 - v_1)$$

Perhaps the electromagnetic paradox can be resolved similarly. In our present state of knowledge, however, radiation seems to result from the propagation of a partial differential equation through space.

R. F. DEIMEL

STEVENS INSTITUTE OF TECHNOLOGY

THE USEFULNESS OF BIOLOGICAL ABSTRACTS

THE receipt of the index to Vol. 11 (1937) of *Biological Abstracts* impels me to relate an experience which demonstrated, to my own satisfaction at least, the usefulness of this abstracting journal. Having to revise for Editor Allen the chapter on "Ovulation, Fertilization and the Transport and Viability of Eggs and Spermatozoa" for the 1939 edition of "Sex and Internal Secretions," and having exhausted the Quarterly Cumulative Index as well as various German Berichte, I turned to the indexes, so far as published, of *Biological Abstracts,* using the appropriate key words such as egg, sperm, ovulation, fertilization, oviduct, etc. The result was gratifying and a little surprising, for over 100 references new to me, including several of considerable importance, were unearthed in this simple way.

The usefulness of *Biological Abstracts* lies in the superb indexing job, the technique of which was worked out by the founder, Dr. Schramm. The indexes are unique in that the aim has been to include not merely main titles but also subordinate, though no less important, subject-matter that would otherwise be hopelessly buried. Now that Editor Flynn is determined to bring the indexes up to date, *Biological Abstracts* should come into its own as a most useful instrument for those who are interested in the broader biological aspects and the "Grenzgebiete" of their subjects.

CARL G. HARTMAN

BALTIMORE, MD.

SCIENTIFIC BOOKS

TERRESTRIAL MAGNETISM AND ELECTRICITY

Terrestrial Magnetism and Electricity. Edited by J. A. FLEMING. Being Volume VIII of the Series "Physics of the Earth" Prepared under the Auspices of Various Committees of the National Research Council. New York and London: McGraw-Hill Book Company, Inc., xii + 794 pp. $8.00.

THIS very valuable volume contains a series of chapters written by various authorities on the fields concerned; and perhaps the best that can be done in the way of a brief summary is to commence by listing the articles under these various chapters, as follows:

	pp.
"The Earth's Magnetism and Magnetic Surveys," by J. A. Fleming	58
"Magnetic Instruments," by H. F. Johnston, J. A. Fleming and H. E. McComb	52
"Magnetic Prospecting," by C. A. Heiland	39
"Atmospheric Electricity," by O. H. Gish	82
"Instruments Used in Observations of Atmospheric Electricity," by O. W. Torreson	39
"Earth-Currents," by W. J. Rooney	38
"On Causes of the Earth's Magnetism and Its Changes," by A. G. McNish	77
"Some Problems of Terrestrial Magnetism and Electricity," by J. Bartels	49
"Radio Exploration of the Earth's Outer Atmosphere," by L. V. Berkner	58
"The Upper Atmosphere," by E. O. Hulburt	81
"The Aurora Polaris and the Upper Atmosphere," by L. Vegard	84
"Thunder-Clouds, Shower-Clouds, and Their Electrical Effects," by B. F. J. Schonland	22

"Bibliographical Notes and Selected References," by H. D. Harradon 99
Index 16

The various chapters are written as far as possible in language which is not too technical, but there is of necessity a wide range in the degree of difficulty involved for the reader. This range extends, however, from an upper limit, which is representative of no more complexity than should be capable of being handled by the average laboratory physicist, to a lower limit of simplicity, in which there is much which should be understandable to the educated layman.

It is naturally not practical to give anything like a detailed review of the individual sections. There is of necessity a fair amount of overlapping, but such a situation presents advantages as well as disadvantages, and the former probably well outweigh the latter.

The last chapter, entitled "Bibliological Notes and References," contains a valuable summary of the different organizations and journals concerned with publications in the fields covered by the book. It also embodies in conveniently classified form an extensive series of references to the literature, based upon the citations in the main text.

The authors are to be congratulated upon bringing together into so convenient and readable a form so many diverse topics bearing directly and indirectly upon the science of terrestrial magnetism and electricity.

W. F. G. Swann
Bartol Research Foundation

MODERN SCIENCE

Modern Science. By Hyman Levy. x + 736 pages. New York: Alfred A. Knopf. 1939. $5.00.

The author, who is professor of mathematics at the Imperial College of Science and Technology, South Kensington, endeavors to present in this volume a "landscape picture of modern science for the ordinary intelligent person." Rather than present a picture which startles and mystifies the reader, as do many books on science for the layman, he emphasizes the simplification of the problems of nature which has been achieved and which constitutes in reality the true aim of science. He includes, however, enough of the curiosities to arouse and hold the interest of the reader.

The volume is a good illustration of the tendency which appears to be greatly increasing to-day, particularly in England, to view science as a whole not as a body of doctrine or a catalogue of empirical results, but as essentially a social phenomenon. The scientific workers themselves and their reasons for undertaking problems are regarded as an important part of the phenomenon, as well as the social implications of the discoveries made. Thus the author attempts to show that during a period of general social unrest there is a corresponding unrest, not only among the scientific workers, but also in the hypotheses which they are contemplating at that time. The scientific results achieved are more dependent on the period than on the men who achieved them. For example, Professor Levy believes that if Newton, by some accident, had not been born, others would have made all Newton's discoveries at practically the same time as they were made. There is intended no disparagement of Newton's genius here, the author's thesis is concerned only with the problems with which Newton was occupied.

Professor Levy treats in some detail the modern practice and the theory behind our present methods of illumination, and attempts in this manner to demonstrate the important consequences, from the point of view of society as a whole, of such abstract and, at first sight, purely theoretical subjects as relativity and the quantum theory.

The style of the book makes for smooth and easy reading, although its length may discourage some. The diagrams are numerous and extremely well done. They sometimes accomplish more than pages of text could do. The volume is well worth the study of many, and in particular of scientific workers who are generally too prone to disregard entirely the implications to society as a whole of the things they are doing and the things they are leaving undone.

C. G. Montgomery
The Bartol Research Foundation of
The Franklin Institute, Swarthmore, Pa.

PREHISTORIC LIFE

Prehistoric Life. By Percy E. Raymond. ix + 324 pp. Illustrated. Cambridge, Mass.: Harvard University Press. 1939. $5.00.

In this charmingly written, thought-provoking book, Dr. Raymond traces the history of life from the time of its first appearance on the earth to the present.

After clarifying our small stock of knowledge of pre-Cambrian life, he discusses the evolution and the manner of life of graptolites, trilobites, aquatic arachnids, corals and echinoderms of the early Paleozoic. Next he considers the origin of the vertebrate stem, outlining clearly the Amphioxus, annelid, arthropod and anaspid theories; he considers the last the most probable. Starting with the lobe-finned ganoids, he discusses the geologic conditions giving rise to the first tetrapods, the amphibians, and through these to the earliest reptiles. To the reptiles he gives five very interestingly suggestive chapters, discussing their rise, expansion and decline, noting the geographic and other environmental influences at work to produce these changes. A chapter each is given to birds, cephalopods, insects and plants, and seven to the mammals. The final chapter on "Retrospect and Prospect" deals with the life of the earth from a philosophical evolutionary point of view.

As viewed in geologic time, organic bodies are constantly changing. Since these bodies are made up of inorganic matter, strong external stimuli are essential in effecting these changes, and the most effective of these stimuli are geologic, since these alone are sufficiently prolonged to change the entire environment. The author, for example, speaks of the Tertiary earth as a new earth, furnishing vegetable food in greater abundance and variety than had ever previously existed. The menace of the reptiles to other animals had largely disappeared, due primarily to the geologic changes which closed the Mesozoic. Under such conditions, it is not surprising that mammals began to thrive greatly and to greatly differentiate.

Dr. Raymond considers the past living forms of the earth, not as resting on a pedestal in a bare room, but in their natural living environment, searching for food, escaping enemies, mating. He describes the beginnings of family life among the vertebrates, their adaptation to life on a terrain similar to that of the present but clad in a more primitive vegetative dress. The author gives background to these animals and makes them live.

The book is enlivened by numerous typical Raymondian expressions. It is probably true that only a man who has thoroughly mastered his subject may treat it at times in a lighter manner, so as to give added enjoyment to both amateur and specialist.

As would be expected in anything written by Dr. Raymond, the subjects are discussed with an open mind as to theories and clearly and concisely in expression. The book is replete with new ways of looking at old facts. It must be read by all teachers of the subject who wish to enliven their lectures and class work, and it should be read by all who are interested in the past life of the earth.

HERVEY W. SHIMER

SOCIETIES AND MEETINGS

THE TENNESSEE ACADEMY OF SCIENCE

THE spring meeting of the academy was held on May 5 and 6 at Murfreesboro. At this meeting a plan for placing the academy library in the custody of the Joint Vanderbilt-Peabody-Scarritt Library was approved and a resolution favoring the purchase and maintenance by the U. S. Forest Service of a Rhododendron Garden area on Roan Mountain was adopted. Dr. Dorr R. Bartoo, of the Tennessee Polytechnic Institute, was awarded the American Association for the Advancement of Science research grant of $75.00 for 1939. Dr. Aaron W. Dicus was appointed to represent the academy at the meeting of the American Association for the Advancement of Science, in December, 1939.

For the fall meeting on December 1 and 2 at George Peabody College the Industrial Arts Building, with three large lecture rooms on the second floor, provided ideal facilities for the general sessions which were held on Friday and Saturday mornings and the sessions of botany, geology and physics on Friday afternoon.

There were 46 papers on the program—20 for the general sessions, 12 for the geology, 7 for the botany and 7 for the physics section. Ten schools were represented—4 in East Tennessee, 4 in Middle Tennessee and 2 in West Tennessee. Members of the Tennessee Valley Authority and of the State Department of Conservation contributed eight papers. Geologists founded the academy and became its chief promoters. In recent years the botanists have led. The geologists now seem to be gaining. The hearty support of the schools, the T.V.A. and State Conservation Department is noteworthy.

The paper by Professor George R. Gage, of Vanderbilt University, on "Two New Tree Diseases of Epidemic Severity in Tennessee" was of both general and local interest. The persimmon wilt, discovered in Tennessee in 1937, is prevalent in at least six counties of Middle Tennessee. No measures of control have been instituted. A virus elm disease which has killed thousands of elms in the middle and lower Ohio Valley is believed to be the cause of the loss of five American elms on the Vanderbilt Campus in the last three years, and the disease may be epidemic in Tennessee.

In an informal report, Dr. Baker, director of the Reelfoot Lake Biological Station, outlined the character of the researches made last summer by the twelve persons who had been accepted by him for scholarships.

Dr. William M. Mebane, vice-president, presided at the dinner meeting on Friday evening at the Hermitage Hotel. After an address of welcome by Dr. D. S. Campbell, of George Peabody College, President Dicus gave the academy address, taking as the subject "Reveries of a Scientist." Following this a motion picture illustrating the effects of mineral element deficiencies in plant growth was shown.

At the business meeting on Saturday morning, the secretary-treasurer, speaking of the activities of the academy, said two annual meetings had been held, 700 copies of the Journal had been published quarterly, between five and six hundred copies had been sent out to more than 400 members, 26 state academies of science affiliated with the American Association for the Advancement of Science, 118 other addresses of scientific bodies, libraries, etc., including 28 in thirteen foreign countries. About 20 per cent. of the reserve fund would have to be used in order to balance income and outgo. Respecting the Reelfoot Lake Biological Station he said that the legislature of 1939 had made an appropriation to the academy of $4,000 for the biennium beginning on July 1, 1939, and the State Department of Conservation had added $500 in consideration of researches made there pertaining to the solution of fish and game problems.

Dr. Clinton L. Baker was reelected director of the Reelfoot Lake Biological Station, and Dr. George R. Mayfield, a member of the advisory committee, each for a term of three years. Dr. John T. McGill, in consideration of his services to the academy during the last fourteen years, was elected honorary president for life, with membership on the executive committee without official responsibility.

OFFICERS FOR THE YEAR 1940

President, C. L. Baker, Southwestern, Memphis; *Vice-President,* F. Lynwood Wren, George Peabody College, Nashville; *Secretary-Treasurer,* Kendall E. Born, Division of Geology, Nashville.

Botany Section, *Chairman,* C. R. Freeman, Teachers College, Memphis; *Secretary,* Stanley A. Cain, University of Tennessee, Knoxville.

Geology Section, *Chairman,* Walter F. Pond, Division of Geology, Nashville; *Secretary,* Kendall E. Born, Division of Geology, Nashville.

Physics Section, *Co-Chairmen,* K. L. Hertel, University of Tennessee, Knoxville; Newton Underwood, Vanderbilt University, Nashville.

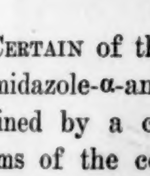
J. T. McGILL

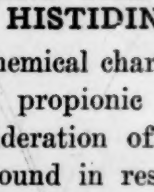
SPECIAL ARTICLES

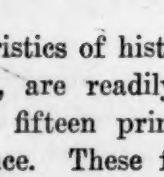
RESONANCE AND THE CHEMISTRY OF HISTIDINE

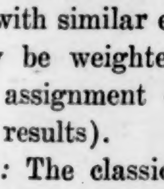
CERTAIN of the chemical characteristics of histidine, β-imidazole-α-amino propionic acid, are readily explained by a consideration of the fifteen principal forms of the compound in resonance. These forms can be classified into four groups, each containing structures with similar energies, and the forms of each group may be weighted somewhat arbitrarily (any reasonable assignment of weights leads to the same qualitative results).

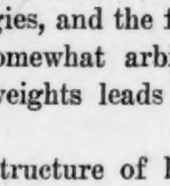
Group 1: The classical structure of histidine (I), where A is the alanine residue. Weighting 30. *Group 2:* Four forms in which there is a single separation of charge and octets about all atoms, *e.g.,* II. Weighting 10. *Group 3:* Five forms containing a single separation of charge, but a sextet about one atom, *e.g.,* III. Weighting 5. *Group 4:* Four structures with a double separation of charge and a sextet about one atom, *e.g.,* IV. In addition, V is placed in this group, due to the two adjacent double bonds. Weighting 2.


I


II

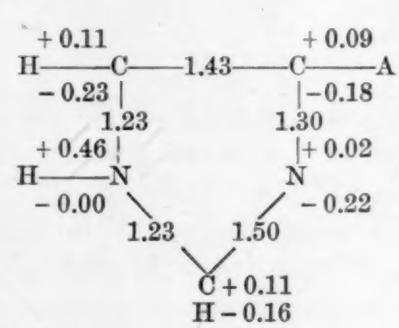

III


IV


V

The resonance forms of the other tautomer of histidine are the same, with the functions of the ring nitrogens reversed.

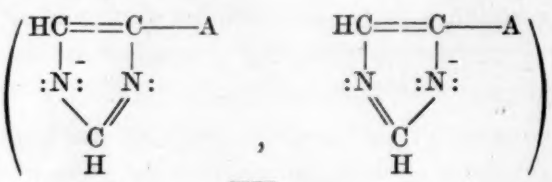
The degree of bondedness between each pair of atoms of the ring and the charges on each atom are summarized in VI as time averages, where one unit of charge (charge on an electron) or bondedness (single bond) is equivalent to a total weighting of 105 (30 + 40 + 25 + 10).


VI

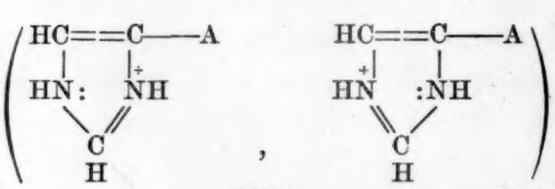
Recalling that a double bond to a nitrogen or a positive charge decreases its basicity and increases its acidity, while a negative charge has the reverse effect, the nature of the three nitrogen atoms of histidine may now be considered. (1) The amino nitrogen of the chain does not participate in the resonance of the ring and therefore is similar both in reactivity and basicity to α-amino groups of other amino acids (*i.e.,* expected pK_b about 5). (2) The secondary amine nitrogen of the ring has a charge of almost $+\frac{1}{2}$ and is not quite $\frac{1}{2}$ double bonded on either side. The similar resonance in pyrrole gives its nitrogen about the same positive charge and degree of bondedness. Thus this nitrogen in histidine, like that of pyrrole, is very weakly basic and abnormally acidic. (3) The third nitrogen, resembling in the classical structure the nitrogen of pyridine, possesses a net charge of $-1/5$. It is double bonded 3/10 on one side and 1/2 on the other. On the other hand, the resonance in pyridine gives the nitrogen a relatively small negative charge and makes it slightly less than half double bonded on each side. As a result the histidine nitrogen is much more basic than that of pyridine.

It is doubtful that the negative charge of this "pyridine" nitrogen can entirely compensate for its doublebondedness, and it is therefore probably less basic than the nitrogen in the alanine residue. The formation of salts of histidine indicates two basic nitrogens, $pK_b = 4.85$ and $pK_b = 7.97$, of which the first corresponds to the nitrogen of an amino acid, and the second to a nitrogen much more basic than that of pyridine.

A similar treatment of the nitrogens of histidine could have been accomplished by a consideration of the alternative resonances VII and VIII,[1] in which the ring has a net charge.



VII



VIII

Substitutions that depend on the basicity of the nitrogen occur at the amino group, *e.g.*, $C_3N_2H_3 \cdot CH_2 \cdot CHNH_2 \cdot COOH + C_6H_5 \cdot SO_2Cl \rightarrow C_3N_2H_3 \cdot CH_2 \cdot CHNH\ (C_6H_5SO_2) \cdot COOH + HCl$. Those that depend on removing a hydrogen by a metal, which is afterwards replaced by a group, occur on an acidic nitrogen of the ring, *e.g.*, $AgN_2C_3H_2 \cdot CH_2 \cdot CHNH_2 \cdot COOAg + 2CH_3I \rightarrow CH_3N_2C_3H_2 \cdot CH_2 \cdot CHNH_2 \cdot COOCH_3 + 2AgI$.

TERRELL L. HILL
GERALD E. K. BRANCH

UNIVERSITY OF CALIFORNIA,
BERKELEY

FURTHER EVIDENCE OF SEX VARIATION IN THE UTILIZATION OF IRON BY ANEMIC RATS

PREVIOUS work in this laboratory has indicated that female anemic rats utilize iron more efficiently than male anemic rats. This conclusion was based on the greater gain of the hemoglobin per 100 milliliters of blood shown by female rats when both male and female rats were fed the same iron supplement.[1] The question has been raised as to whether this is really a characteristic of the female organism or is simply due to the difference in the size of the two sexes and therefore different food intakes.[2] In the hope of shedding further light on this question, the total iron content of anemic male and female rats which have been given supplemental iron feedings has been investigated.

Anemia was produced in young rats using the Elvehjem-Kemmerer technique,[3] modified only by the feeding of copper sulfate supplements, as is customary in this laboratory.[4] When the rats were eight weeks old, the hemoglobin level was constant or falling, and ranged from 2.9 to 5.4 gms Hb/100 ml. of blood for the six litters used in this work. At this time representative rats from each litter were killed, while the rest of the rats were placed on $FeCl_3$ supplements varying from 0.05 mg Fe to 0.3 mg Fe daily. At the end of the six weeks' test period and twenty-four hours after the feeding of the last iron supplement, the hemoglobin concentration was determined by the acid-hematin method and the rats killed. After the removal of the digestive tract, the rats were ashed and the hydrochloric acid solution of the ash analyzed for iron, using the method of Farrar.[5]

Results of the iron analyses of the rats given comparable treatment showed remarkable agreement. Six male and seven female rats were killed at the end of the five weeks' iron depletion period on the basal milk diet. Although the hemoglobin concentration ranged from 2.9 to 5.4 gms of Hb/100 ml. blood, the iron content varied only from 0.013 to 0.017 mg Fe/gm of rat with an average of 0.015 mg Fe/gm for both male and female rats. However, as the females weighed a little more than the males, the total iron content of the females (0.8073 mg Fe) was slightly higher than that of the males (0.7065 mg Fe). In another series of experiments the iron depletion period was continued for eleven weeks and although there was a definite decrease in both the hemoglobin concentration and the iron content, again no sex difference in the iron content of rats which had their reserves depleted on a milk diet régime could be detected.

However, Table I shows the results obtained when litter mate rats rendered anemic by the usual procedure were fed varying amounts of iron as $FeCl_3$ solution. It can be seen that the mg Fe/gm of rat was always higher for the females than for the males fed

1 Jukes and Branch, SCIENCE, 80: 228, 1934.

1 M. C. Smith and L. Otis, SCIENCE, 85: 125–126, 1937.
2 H. H. Mitchell and T. S. Hamilton, SCIENCE, 85: 364–366, 1937.
3 C. A. Elvehjem and A. R. Kemmerer, *Jour. Biol. Chem.*, 93: 189–195, 1931.
4 M. C. Smith and L. Otis, *Jour. Nutr.*, 14: 365–369, 1937.
5 G. E. Farrar, Jr., *Jour. Biol. Chem.*, 110: 685–694, 1935.

the same iron level. It is interesting to note also that at the lowest levels of iron fed—when most economical use of the iron is of vital importance—the females actually retained more iron than the males, in spite of their smaller size.

TABLE I

ANALYSES OF RATS AFTER RECEIVING IRON SUPPLEMENTS

Mg Fe fed daily	Sex	No. of rats	Avg. 6 wks. gain in wt. grams	Avg. 6 wks. gain in HB Hb/100 ml blood	Avg. total mg Fe/rat	Avg. mg Fe/gm
.05	♂	3	90	1.9	2.3666	.017
.05	♀	3	71	5.8	3.3083	.026
.10	♂	3	100	5.3	3.5335	.020
.10	♀	4	72	8.7	4.2765	.029
.20	♂	5	120	8.9	5.0328	.032
.20	♀	6	83	10.4	4.3545	.035
.30	♂	1	153	11.0	7.2250	.039
.30	♀	3	83	11.5	5.2798	.045

To check this point further, male and female rats were compared that were fed the same iron supplement and whose gain in weight during the six weeks' test period was the same. When fed 0.05 mg Fe daily, the male rat gained 74 grams in weight and 2.3 gms Hb/100 ml blood and retained 2.1229 mg Fe or 0.018 mg Fe/gm, while the female rat gained 75 grams in weight and 5.1 gms Hb/100 ml blood but retained 3.7500 mg Fe or 0.027 mg Fe/gm. When the iron supplement was 0.20 mg Fe daily the male rat gained 100 grams in weight and 7.5 gms Hb/100 ml blood and retained 3.5707 mg Fe or 0.027 mg Fe/gm, while the female rat gained 102 grams in weight and 10.3 gms Hb/100 ml blood and retained 4.6832 mg Fe or 0.037 mg Fe/gm.

Thus, from a study of the total iron content of rats, it has been shown that at the end of the iron depletion period the iron content of male and female rats is very nearly the same. However, after feeding iron supplements to anemic rats, the bodies of female rats were found to contain more iron than those of males comparably fed. These results support the previous findings of this laboratory that there is a true sex difference in the way male and female rats utilize iron and that it can not be explained by a difference in the weights of the two sexes.

LOUISE OTIS
MARGARET CAMMACK SMITH
UNIVERSITY OF ARIZONA

ON THE ORIGIN OF UROGASTRONE[1]

THE presence of a substance in human and canine urine which inhibits the gastric secretory response to histamine and a meal has been previously demonstrated.[2,3,4,5] This substance has been called urogastrone[5] because of its resemblance to enterogastrone, which inhibits gastric secretion and motility.[6] The latter principle is liberated from the upper intestinal mucosa in response to contact with fat.

The experiments reported here were designed to answer two questions: Will urogastrone disappear from the urine following combined subtotal gastrectomy and total enterectomy? Is the output of urogastrone increased by feeding a high fat diet?

From four female dogs prepared and trained for catheterization, urine was collected successively under the following conditions: (*a*) daily for a 5-hour period after the ingestion of 75 cc of corn oil with a mixed meal; (*b*) for a 4-day period during which they received daily approximately 1,200 cc of a modified dextrose-free Locke's solution subcutaneously, but no food; and (*c*) for a period of a week after an operation in which the pyloric antrum and the entire small intestine were removed, the pancreatic ducts tied, the pancreas separated from the duodenum by a subserous resection of the latter, and external gastric and biliary fistulas constructed. During this post-operative period, modified dextrose-free Locke's solution was administered. With one exception, the animals survived considerably longer than one week. The catheterized urine was treated by the method of Katzman and Doisy,[7] and the resulting extracts were assayed in six Heidenhain-pouch dogs injected with histamine. The results are shown in Table 1.

TABLE 1

Experiment	No. of assays	Dose				Inhibition of gastric secretion of free acid in per cent.
		Mgms.	Urine equiv. in cc	Equiv. in hours	Equiv. in kg. hrs.	
Dogs 1, 2, 3, 4 (urine pooled)						
Fat fed ..	29	4.2	207	7.64	128	44
Fasted ...	18	5.3	393	12.03	205	32
Enterectomized ..	24	7.5	199	13.29	208	3

The results clearly demonstrate, first, that the ingestion of a high fat diet augments the excretion of urogastrone; and second, that urogastrone disappears from the urine following surgical removal of the small intestine. In these respects urogastrone behaves exactly as would be expected if it represents excreted enterogastrone. Accordingly, our experiments provide strong circumstantial evidence in favor of this inter-

[1] Aided in part by a grant from the Committee on Endocrinology of the National Research Council.

[2] C. U. Culmer, A. J. Atkinson and A. C. Ivy, *Endocrinology*, 24: 631, 1939.

[3] J. S. Gray, E. Wieczorowski and A. C. Ivy, SCIENCE, 89: 489, 1939.

[4] J. S. Gray, E. Wieczorowski and A. C. Ivy, *Am. Jour. Physiol.*, 126: 507, 1939.

[5] J. S. Gray, C. U. Culmer, E. Wieczorowski and J. L. Adkison, *Proc. Soc. Exper. Biol. and Med.* In press.

[6] A. C. Ivy and J. S. Gray, *Cold Spring Harbor Symposia on Quant. Biol.*, 5: 405, 1937.

[7] P. A. Katzman and E. A. Doisy, *Jour. Biol. Chem.*, 98: 739, 1932.

pretation. However, they do not permit the unreserved conclusion that urogastrone is formed by the small intestine, inasmuch as the effect of control surgical procedures on the excretion of urogastrone is as yet unknown. It should be pointed out that the selection of a proper control experiment is inseparable from the more general question of why urogastrone should be excreted in the fasting urine. Experiments are now in progress which are designed to provide at the same time an answer to this general question as well as controls for the experiments reported here.

C. U. CULMER
J. S. GRAY
J. L. ADKISON
A. C. IVY

DEPARTMENT OF PHYSIOLOGY,
NORTHWESTERN UNIVERSITY,
CHICAGO, ILL.

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A ROLLER BOTTLE TISSUE CULTURE SYSTEM[1]

IN 1936 Gey and Gey[2] described procedures which they employed in maintaining *in vitro* tissue cultures of normal and malignant cells in roller tubes. Cultures are grown in a thin layer of clotted plasma on the walls of ordinary or specially designed glass tubes, and by revolving them horizontally they are alternately in contact with a nutrient medium and with air or any gaseous mixture that may be desired. The rotation gives a constant, slow washing action which seems to promote an adequate exchange of food materials and waste products between the supernatant fluid and the cells. The Gey roller tube method has several advantages over the more usual hanging drop, Maximow slide or Carrel flask techniques, but has certain disadvantages and limitations which we believe to be partially eliminated by the modifications in technique described below.

It is difficult and time-consuming to prepare the sterile human normal and placental sera as described in the original articles.[2,3] For experiments of a few weeks' duration we believe the substitution of the "synthetic medium," described by Baker[4] in 1936, is helpful. In roller tube cultures of various human and animal normal and malignant tissues we have obtained very vigorous and healthy outgrowths, even when this medium has been simplified by omission of hemin, insulin, thyroxine and vitamins A and D. Directions for the preparation of this and other media are given in a recent book by Parker[5] and by Baker and Ebeling[6]. Synthetic media have the great advantage that their components can be varied at will.

The danger of contamination during feeding and transfer of roller tube cultures is a serious one, since contact of the nutrient fluid with the stopper is difficult to avoid. We have found it advantageous to employ an arrangement shown in Fig. 1. A short length of

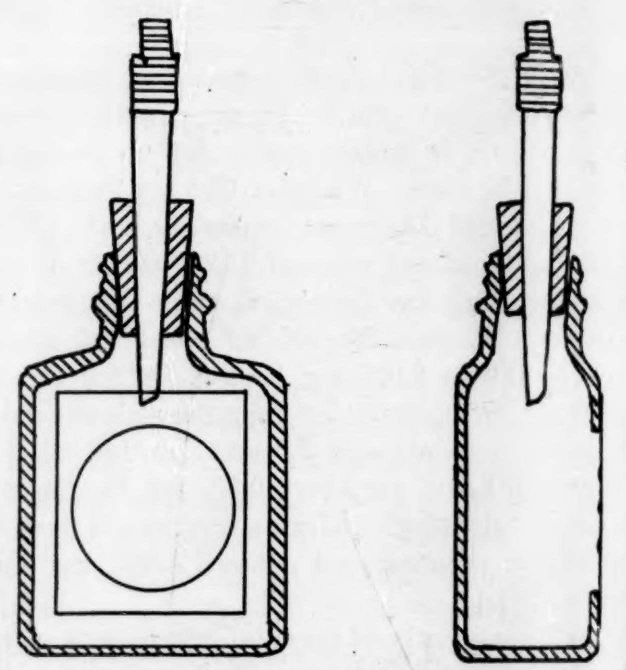


FIG. 1. Cross section views of roller bottle, with stopper and coverslip in place.

Pyrex tubing having a slight constriction at one end is introduced through a hole in a tightly fitting rubber stopper. The two parts are sterilized as a unit, by autoclaving in large Pyrex test-tubes. A sterilized, inverted serum vial cap may be used to seal the end of the small tube after flaming it. For ordinary procedures this cap is removed, and the end of the small glass tube flamed. Fluid transfers can then be made by means of sterile syringes and long hypodermic needles.

Observations of the colonies under highest magnification is impossible in ordinary glass roller tubes, due to the thickness and curvature of the walls. Gey[3] in 1933 described the construction of special hexagonal tubes having flat sides of thin glass which were better suited to higher power observations (*i.e.*, 45 × objectives). Even with these, however, satisfactory permanent stained specimens would be difficult to prepare and store and would involve sacrifice of the tubes.

[1] Aided by a grant from the National Research Council. From the Laboratories of the Collis P. Huntington Memorial Hospital of Harvard University.

[2] G. O. Gey and M. K. Gey, *Am. Jour. Cancer*, 27: 45, 1936.

[3] G. O. Gey, *Am. Jour. Cancer*, 17: 752, 1933.

[4] L. E. Baker, SCIENCE, n.s., 83: 605, 1936.

[5] R. C. Parker, "Methods of Tissue Culture," Paul B. Hoeber, Inc., 1938.

[6] L. E. Baker and A. H. Ebeling, *Proc. Soc. Exp. Biol. and Med.*, 39: 291, 1938.

Therefore, we have constructed flat roller bottles, as shown in the figure, which appear to offer many advantages. A hole 33 mm in diameter is drilled in the wall of an ordinary commercial flat-walled, two-ounce bottle. Then a 43 by 50 mm No. 1 or No. 2 cover glass is cemented over this opening with a suit-ble plastic cement which should be non-toxic and nsoluble in water after dry heat sterilization, but oluble in alcohol as is "Gelva" (kindly supplied by he Shawinigan Resins Corporation), or soluble in cetone as is "Glyptal number 1202" (made by the General Electric Company). These cements seem omewhat soluble in water if heated for only three or our hours at 160 degrees Centigrade and hence should e left overnight at this temperature. Since 80 per ent. alcohol is used in many staining procedures and asily dissolves the "Gelva," this cement is recom-ended for use when the cover slip will be removed. "Glyptal" may prove better for cementing cover slips hich are to be left on and used several times before enewal. In practice the bottle is washed and dried; thin layer of cement is applied with a medicine ropper around the edges of the hole and on the djacent flat outside wall of the bottle; then a cover ip is placed on the cement and manipulated to remove r bubbles. A fairly loose non-absorbent cotton plug inserted in the neck of the bottle which is placed, over slip side up, in a wire basket or rack, ready for ry heat sterilization.

To plant the cultures, bottles are lined up on a sterile ck or towel, cover slip side down, the cotton plugs e removed, and the necks flamed gently. Then, in ch bottle, from two to four drops of sterile heparin-ed plasma are placed directly on the inside surface the cover slip and distributed evenly, after which e excess is drawn off, leaving a very thin film con-ining about one drop of plasma. It is unnecessary deposit any plasma on the other walls of the bottle less tissue is to be planted there as well. Next, from e to twenty or more fragments of finely chopped tis-e in Baker's medium or saline are drawn into a pette, concentrated in the tip, and allowed to fall the cover slip. The excess fluid is now drawn off d a sterile stopper unit is placed in the flamed neck. ter allowing the clot to harden slightly, fluids may added through the small Pyrex tube by means of a podermic needle and syringe. (A total of about 5 cc satisfactory.) Usually no embryo extract or other tting factors will be required. Finally, the tip of small Pyrex tube is flamed and covered with a rile inverted serum vial cap. The culture is now dy for incubation.

Cultures seem to grow better if they are rotated m six to fifteen revolutions per hour, thus giving aerating and washing action to the supernatant fluid Gey[2] describes for his roller tube method. However, they may be grown in these roller bottles without motion, as in Carrel flasks.

We recommend the use of a small synchronous-type electric motor such as the Telechron C-2 or C-4,[7] which will be found to have ample torque to rotate a shaft carrying a balanced roller bottle box capable of holding twenty-four bottles at a speed of fifteen revolutions per hour. Using a stock motor with a shaft speed of one r.p.m., only one small four-to-one reduction gear is required. Elaborate bearings are unnecessary, and the whole apparatus will occupy a space of less than $3 \times 2 \times 2$ feet inside an incubator.

In staining cultures, the preliminary fixation and washing are best done with the cover slip still on the bottle. Then, after allowing the bottle to remain in contact with the proper solvent for a few hours, the cover slip and preparation may be removed *in toto* for subsequent staining and mounting, leaving the roller bottle ready for re-use. Since the colonies grow in a very thin plasma coagulum and tend to form extensive sheets, often only one or a few cells thick, exceptionally good cytoplasmic and nuclear detail may be observed without any intermediate transfer or sectioning procedures, and the usual difficulties encountered in staining cultures in thick clots are eliminated.

Numerous possible uses for the apparatus suggest themselves. The bottles are well adapted to the taking of frequent photomicrographs or cinematographs. The injection of test solutions, viruses or bacteria can be timed accurately, and since a very thin plasma clot may be used, penetration to the cells is very rapid. By the use of two holes and cover slips in opposite sides of the bottle, treated and untreated tissue could be nourished by the same nutrient solution, or the growth and action of viruses or bacteria on immune and non-immune tissues could be studied readily in the same container. Cultures of different endocrines could be handled the same way and their interactions on one another or their response to hormones determined.

A similar technique using thin organic films in place of cover slips has been developed in collaboration with the Haskins Laboratories[8] for use in radiation experiments.

The method obviously has advantages in studies in which optimal cultural conditions should be combined with microscopic studies of living and stained tissue, and hence appears to be a useful improvement in technique.

Darrel T. Shaw,
Lucius N. Littauer fellow in cancer
Lawrence C. Kingsland,
Bullard fellow
Austin M. Brues
Harvard University

[7] C-2M for larger installations.
[8] Haskins Laboratories, 480 Lexington Ave., New York, N. Y.

THE USE OF A TRANSLONGITOME IN MAKING AND INTERPRETING ALTERNATE TRANSVERSE AND LONGITUDINAL SERIAL SECTIONS

BOTANISTS and zoologists have long recognized the difficulty encountered in interpreting the relationship of parts in transverse and longitudinal sections made from two different pieces of tissue. An alternating two-plane cutting attachment to be used in a rotary or sliding microtome has been developed by the writer. This instrument has been named a "Translongitome" at the suggestion of Dr. E. J. Kraus, Botany Department, University of Chicago. This device makes it possible to cut alternate transverse and longitudinal sections from the same block of tissue so that the alternate sections come from the microtome knife in one continuous ribbon.

The translongitome is fastened into the microtome clamp in relation to the microtome knife as shown in Fig. 4. This makes the sector swing through a 90-degree arc in a plane parallel to the knife edge. The hinged sector automatically locks or releases for each predetermined position. It is necessary to set the microtome to cut one half of the thickness desired as each face of the block is cut on alternate strokes. After adjustments are made for the two faces to come to the knife in the same plane and the paraffin trimmed for the correct width of ribbon the microtome is turned with a quick movement, stopping with the translongitome up each time and the sector shifted to the reverse position by means of the handle. The detail of the locking device and two-plane adjustment is not shown in the diagram.

Figs. 1, 2 and 3 indicate the method of preparing the paraffin block for attachment to the translongitome. Fig. 4 indicates a portion of the paraffin ribbon coming from the microtome knife. This paraffin ribbon is prepared in the usual manner and studied as serial sections. Fig. 5 shows the finished slide as the longitudinal and transverse sections appear in separate rows. It may be observed that the upper edge of the transverse sections matches the extreme lower edge of the longitudinal sections. Observation under the microscope of course makes these edges appear to be the inner rather than outer edges. A particular bundle or structure in transverse section will appear closer and closer to the cutting edge after each successive cut and when it reaches the cut edge it will appear in the next longitudinal section. It is always possible to determine the direction of the longitudinal cut with respect to the structure and to know the structure involved from the adjacent transverse sections. The cut edges show practically no disruption of parts, and it is possible to take a photomicrograph of a successive transverse and longitudinal cut edge and to match edges part for part or even cell for cell.

Slides prepared by this method are of great assistance in interpreting and determining relationships of parts in original research and are especially helpful in instruction in vascular anatomy.

D. M. CROOKS

UNIVERSITY OF ARIZONA

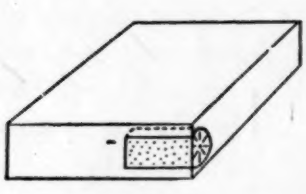


FIG. 1.

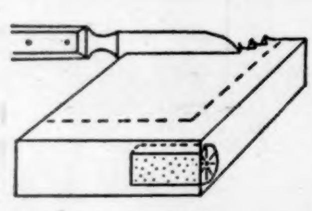


FIG. 2.

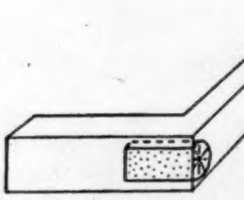


FIG. 3.

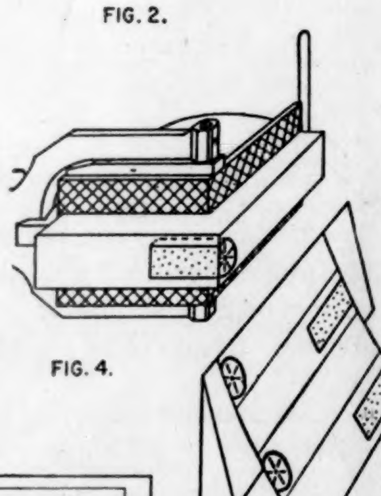


FIG. 4.

FIG. 5.

BOOKS RECEIVED

Calcutta School of Tropical Medicine and the Carmichael Hospital for Tropical Diseases, Report, 1938. Pp. 1... Bengal Government Press, Alipore.

DERANIYAGALA, P. E. P. *The Tetrapod Reptiles of Ceylon. Vol. I, Testudinates and Crocodilians.* Pp. xxii + 412. 137 figures. 24 plates. Colombo Museum, Ceylon. Rs. 10/.

HENDREN, LINVILLE L. *A Survey of Physical Science, Part I, Physics and Astronomy.* Pp. x + 556. Illustrated. *A Survey of Elementary Physics.* Pp. x + ... Illustrated. University of Georgia Press, Athens.

Mellon Institute Bibliographic Series. *Bulletin No. 4; List of Books, Bulletins, Journal Contributions and Patents by Members of Mellon Institute, 1911-19...* Pp. v + 242. The Institute, Pittsburgh.

National Research Council of Japan. *Japanese Journal of Botany; Transactions and Abstracts. Vol. X, Nos. 1–2.* Pp. v + 211 + 30. Illustrated. *Japanese Journal of Geology and Geography; Transactions and Abstracts, Vol. XVI, Nos. 1 and 2. July, 1939.* Pp. viii + 204 + ... The Council, Tokyo.

PILSBRY, HENRY A. *Land Mollusca of North America North of Mexico. Vol. 1, Part 1.* Monograph No. ... of the Academy of Natural Sciences of Philadelphia. Pp. xxvi + 573. 377 figures. The Academy, Philadelphia.

STRECKER, EDWARD A. *Beyond the Clinical Frontiers.* Pp. 210. Norton. $2.00.

WHEELER, RAYMOND H. *The Science of Psychology.* ... xviii + 436. 78 figures. Crowell. $2.75.